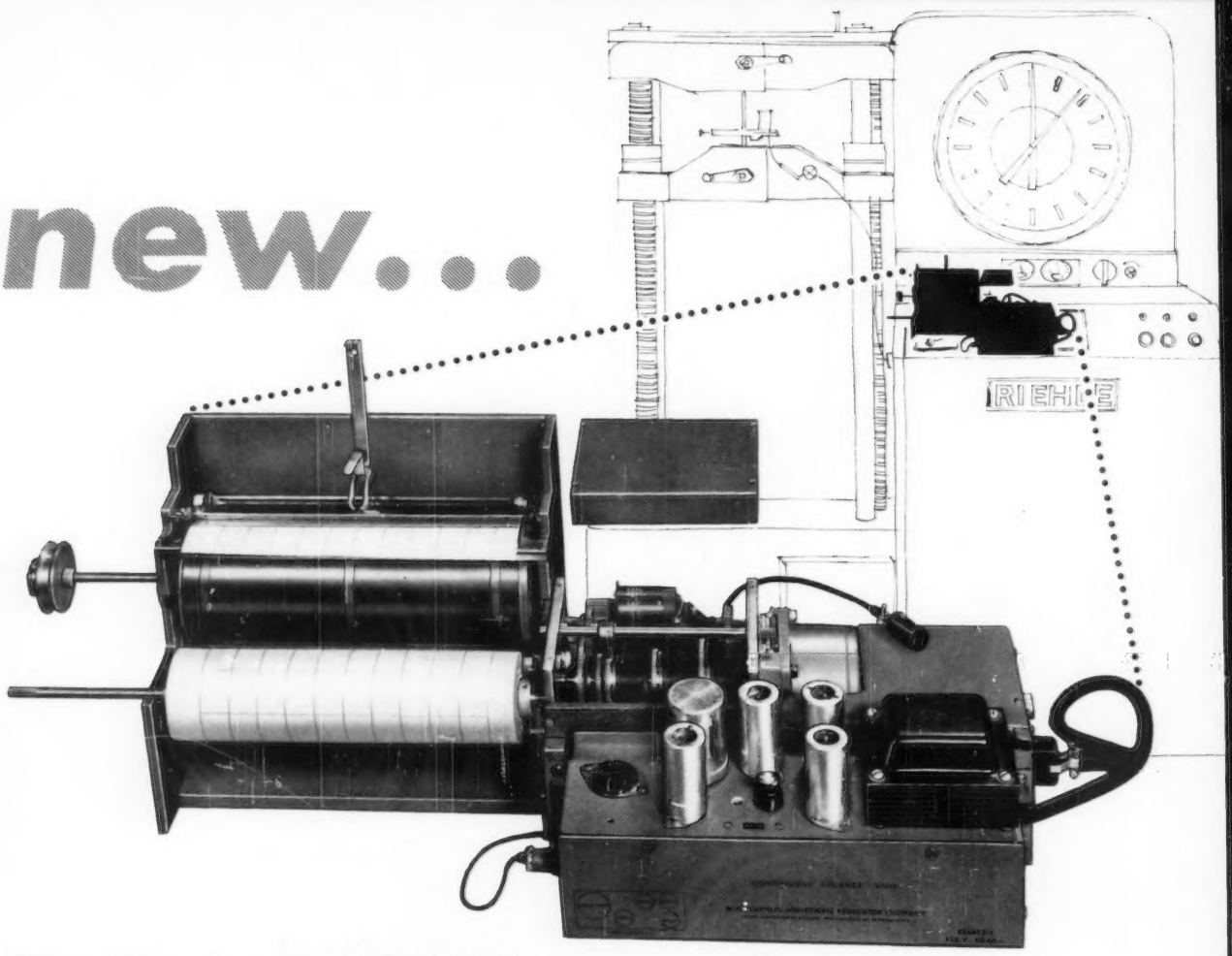
ASTM Bulletin

COMMITTEE WEEK

St. Louis February 10–14

new...



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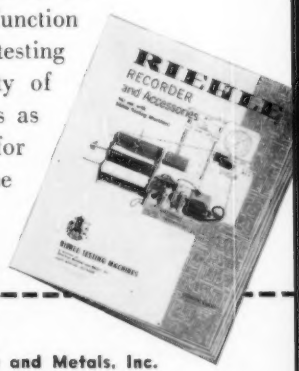
Here is true convenience, because the Riehle recorder is expressly designed to function as an integral part of the Riehle testing machine. And a complete variety of Riehle strain follower instruments as well as special instrumentation for elevated temperature testing can be accommodated.



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ASTM BULLETIN

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RMATION CIRCLE 710 ON READER SERVICE CARD PAGE 105

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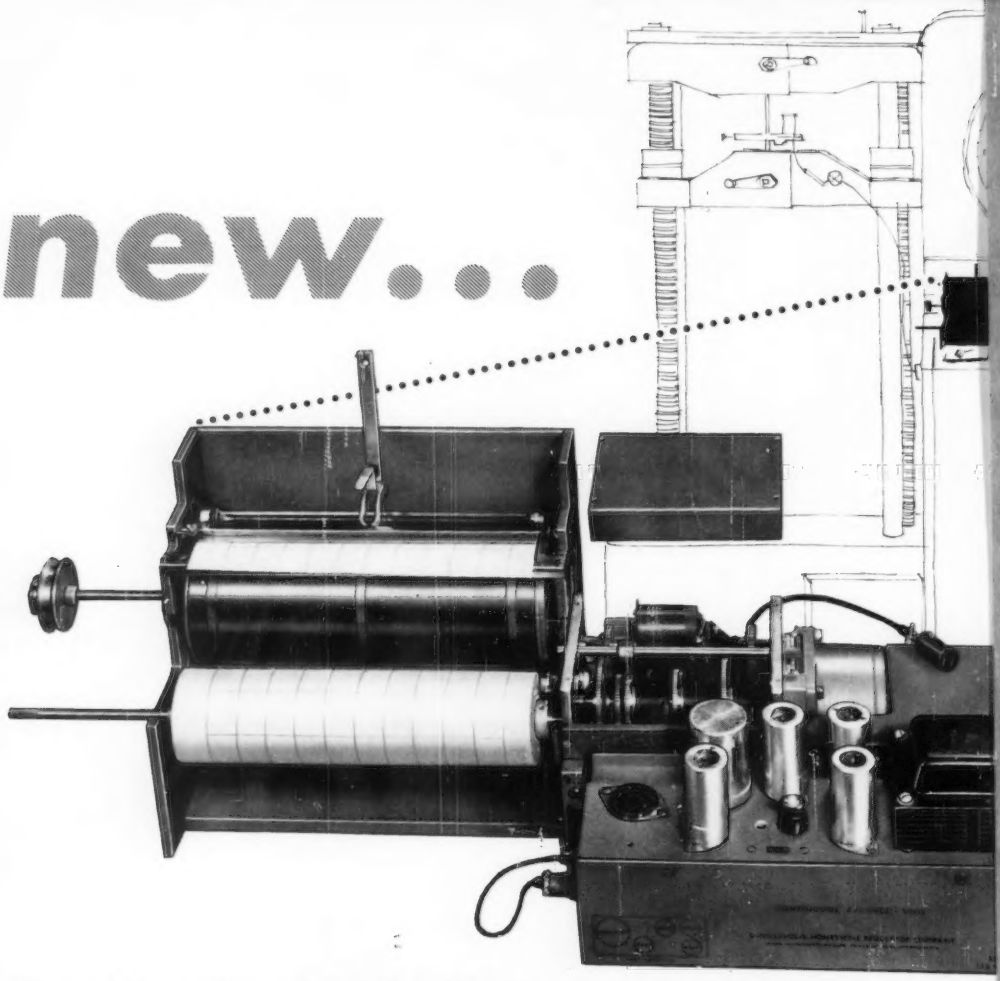

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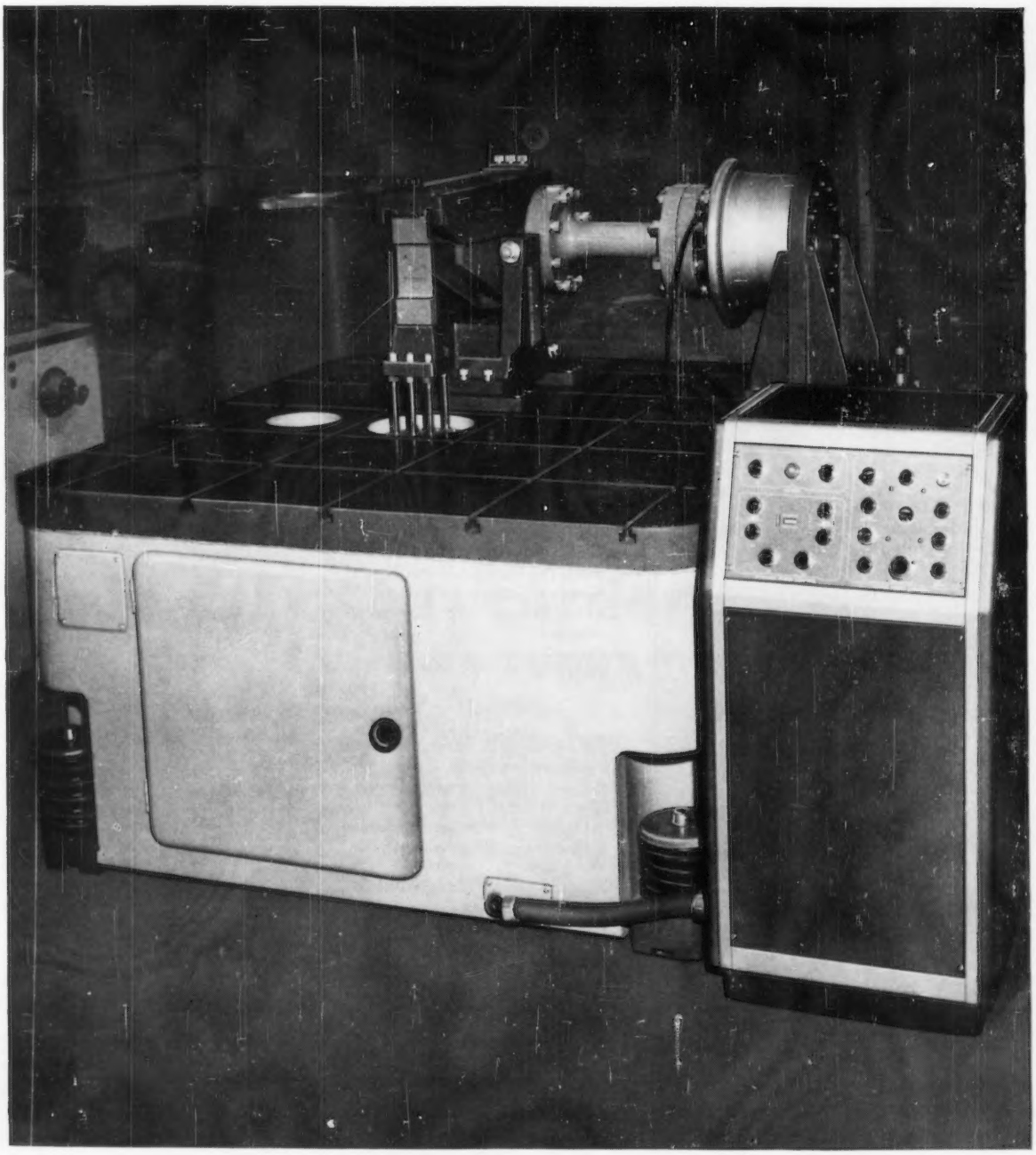
NEWS FROM B-L-H

Introducing the I-V MULTI-RANGE



Fixture mounted on Model I-V 20 is putting an aircraft brake assembly through a series of fatigue tests. Separate console locates electronic control equipment away from vibration.

FOR FURTHER INFORMATION CIRCLE 711 ON READER SERVICE CARD PAGE 105

new and complete line of

FATIGUE TESTERS

In six sizes with capacities ranging from 200 to 120,000 lb. at the high load station and amplitudes up to ± ¾ in. maximum at the high amplitude station

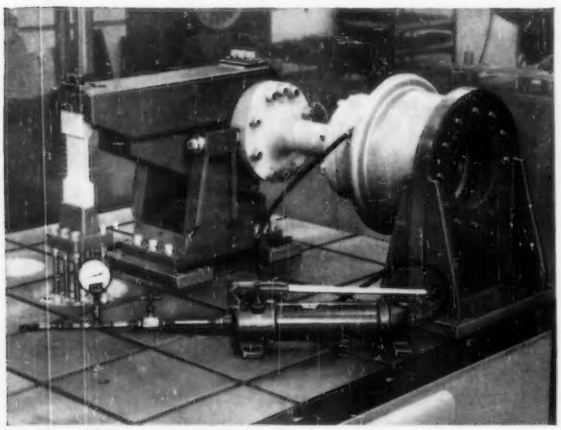
Now ready for delivery, the new B-L-H line of I-V multi-range fatigue testing machines meets an unusually broad variety of requirements. Whether for production testing of machine members, components and structural assemblies, or for testing research specimens, I-V Fatigue Testers offer you high accuracy, combined with maximum versatility and simplicity of operation. By use of suitable fixtures, the possible combinations of static and dynamic loads permit the simulation of almost any service condition.

A 5 to 1 force-multiplying fixture can be added to all models. For example, it will increase the load capacity of Model I-V 120 from 120,000 to 600,000 lb.

A unique feature of the I-V Fatigue Tester is its multi-range design. This provides two loading stations, one for applying full force capacity and one for high amplitude tests up to ± ¾ in. maximum. Amplitude limits, automatically maintained while the machine is running, permit stopping of a test just before complete specimen separation to allow metallurgical examination of the region of crack initiation.

The three smaller models, I-V 02, I-V 1 and I-V 4, are available in operating frequencies of either 1200 or 1800 cpm; the larger models, I-V 20, I-V 50 and I-V 120, of only 1200 cpm.

For the best in testing, see B-L-H first. You can choose from the industry's most complete line of testing equipment, including tension, compression, creep, fatigue, impact or torsion. For more information on I-V Fatigue Testers, write for a free copy of Bulletin 4217. Or ask to have a B-L-H representative stop in and see you.



Closeup of wheel-and-brake test fixture showing hydraulic pump used to apply brake pressure.

Model I-V 20H (with furnace and high temperature fixture). Special control panels record temperature and creep.

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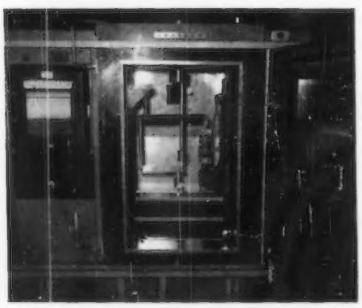
This is the U. S. Army surface-to-air Nike-Hercules Missile which incorporates a solid propellant sustainer unit developed and produced by Thiokol Chemical Corporation.

How Thiokol uses the Instron Tester



Tensile testing solid propellants at elevated temperatures. Lever mechanism shown here accelerates rate of strain achieved by Instron's electronically controlled crosshead. Note that jaws grasp dumbbell-shaped sample at edges to reduce possibility of propellant failure at other than its minimum cross section.

Solid propellant rocket engines, developed and produced by Thiokol Chemical Corporation, are the power plants that put the "go" into many of our guided missiles.

The solid propellant that powers these engines must be resilient enough to withstand extreme temperatures and very rough handling. Thus, numerous tensile tests are required to determine how each propellant formulation will perform in a rocket engine.

In performing these critical tests, Thiokol relies on the electronic accuracy of the **Instron Universal Testing Machine.**

Thiokol is another in the long list of leading companies in many different fields who count on Instrons to perform universal testing and measuring functions, including tension, compression, hysteresis and elastic modulus . . . *on materials ranging from acetate to zirconium.*

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W. M. Holaday—Director of Guided Missiles—To Speak at ASTM Committee Week

Veeder and Hochwalt Will Address Steel and Chemical Industry Luncheons in St. Louis the Week of February 10

W. M. HOLADAY, Director of Guided Missiles will be guest of honor and chief speaker at a dinner on Wednesday February 12 during ASTM Committee Week in St. Louis. Two prominent St. Louisans, N. P. Veeder, president of Granite City Steel Co. and Carroll A. Hochwalt, vice-president and director of research of Monsanto Chemical Co., will address the Steel Industry and Chemical Industry Luncheons respectively, on Tuesday and Wednesday noons, February 11 and 12.

For this first Committee Week ever to be held west of the Mississippi, a registration of 1200 is expected, based on the holding of about 300 committee and subcommittee meetings at the Hotel Statler.

William M. Holaday, U. S. Director of Guided Missiles, was for many years Director of the Research Laboratories at Socony-Mobil Oil Co., Inc. In this capacity he was much interested in ASTM (of which he is a member) particularly in Committee D-2 on Petroleum Products and Lubricants. He was on loan in the '40's to the Department of Defense concerned with fuel and power problems and about two years ago again returned to the Department of Defense where he was responsible for important research activities. Before becoming Director of Guided Missiles, he was Special Assistant to the Secretary of Defense.

St. Louis General Committee

Local arrangements for the meeting including the complete responsibility for the dinner are in the charge of a general committee on arrangements headed by A. Carl Weber, Laclede Steel Co. The nucleus of the membership is the St. Louis District Council where John Wendling, City of St. Louis, is Chairman; Willett C. Magruder, Carter Carburetor Co., Vice-Chairman; and A. M. Siegel, Industrial Research and Testing Labs., Secretary. Numerous other active St. Louis members and committee members are assisting.

Invitations are to be extended to leading industrialists and technical executives in the St. Louis area to be present at the luncheons and dinner.

A "dutch treat" cocktail party will precede the dinner.

The plan for plant visits as noted in a short separate article here places a responsibility on the visiting ASTM members to contact laboratories.

St. Louisans to Arrange Plant Visits

St. Louis, eighth largest city of the United States, is one of the industrial giants of the midwest. A wide diversification of industries, many old, many new, will provide numerous opportunities for members and committee members to visit plants and laboratories of interest to them. A Plant Visits Committee composed of C. Howard Adams, manager, Plastics Products Development, Monsanto Chemical Co.; D. C. Brand, coordinator of standards, Engi-

These committees are scheduled to meet in St. Louis . . .

As this issue of the BULLETIN goes to press, the committees listed below have indicated their intention to meet in St. Louis. The *official call* for the meeting will come from the officers of the committees themselves.

A-1 on Steel
A-3 on Cast Iron
A-5 on Corrosion of Iron and Steel
A-6 on Magnetic Properties
A-7 on Malleable-Iron Castings
A-10 on Iron-Chromium-Nickel and Related Alloys
B-6 on Die-Cast Metals and Alloys
B-7 on Light Metals and Alloys
B-8 on Electrodeposited Metallic Coatings
C-4 on Clay Pipe
C-7 on Lime
C-8 on Refractories
C-11 on Gypsum
C-12 on Mortars for Unit Masonry
C-15 on Manufactured Masonry Units
D-4 on Road and Paving Materials
D-5 on Coal and Coke
D-7 on Wood
D-8 on Bituminous Waterproofing and Roofing Materials
D-11 on Rubber and Rubber-Like Materials
D-16 on Industrial Aromatic Hydrocarbons and Related Materials
D-24 on Carbon Black
E-1 on Methods of Testing
E-4 on Metallography
E-5 on Fire Tests of Materials and Constructions
E-7 on Nondestructive Testing
E-9 on Fatigue
E-10 on Radioisotopes and Radiation Effects
Administrative Committee on Simulated Service Testing

neering Dept., Monsanto Chemical Co.; and H. H. Zuidema, research chemist, Shell Oil, is arranging a list of plants and laboratories which will welcome visitors. There will be no organized visits to plants. However, each plant will provide the name of an individual to contact, hours during which visitors will be received, advice on how to reach the plant and other pertinent data. This list will be made available during the meeting at the registration desk.

Committee Meetings

Two of the technical committees are holding sessions at which papers will be presented. Committee D-11 on Rubber has arranged a two-session symposium dealing with ozone problems and Committee C-15 on Manufactured Masonry Units is developing a session on mortar problems. Titles and authors of the rubber symposium are as follows:

Chemical Antiozonants and Factors Affecting Their Utility—*W. L. Cox, Universal Oil Products Co.*

The Study of the Action of Ozone with Polybutadiene Rubber and the Inhibition of This Action—*E. R. Erickson, Augustana Research Foundation*

Prevention of Ozone Attack on Rubber by Use of Oils and Waxes—*S. W. Ferris and J. S. Sweely, Sun Oil Co.*

Rubber and Its Environment—*A. J. Haagen-Smit, California Institute of Technology*

Ozone Resistance of Elastomeric Vulcanizates—*R. F. Shaw, Ordnance Corps, Rock Island Arsenal*

The Reaction of Ozone with Rubber—*Harold Tucker, B. F. Goodrich Research Center*

Comparison of Accelerated and Natural Tests for Ozone Resistance of Elastomers—*G. N. Vacca, Bell Telephone Laboratories, Inc.*

Methods of Measuring the Extent of Ozone Cracking—*A. G. Veith, B. F. Goodrich Research Center*

Papers and discussion in the informal sessions of the mortar group will cover these topics:

What are the essential properties of a good mortar?

Are the current ASTM specifications and test methods adequate?

Can the quality of mortar used on the job be satisfactorily controlled?

Research on the durability of mortars

Recent or current research

Further information on Committee Week will be sent to our members by mail in December. This mailing will include reservation forms for luncheons and the dinner. It will be a tremendous help to the St. Louis committee if as many reservations as possible are made in advance.

Actions on Standards

The Administrative Committee on Standards is empowered to pass on proposed new tentatives and revisions of existing tentatives and tentative revisions of standards offered between Annual Meetings of the Society. On **November 1, 1957** the Standards Committee took these actions:

IRON-CHROMIUM-NICKEL AND RELATED ALLOYS

Standard Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Plate, Sheet, and Strip for Fusion-Welded Unfired Pressure Vessels (A 240 – 54)

Standard Specification for Hot-Rolled and Cold-Finished Corrosion-Resisting Steel Bars (A 276 – 55)

Revision and Reversion to Tentative.—Committee A-10 has added several grades of steel to these specifications and made other changes to bring them in line with present commercial practice. Approval of these revisions carried with it the withdrawal of the emergency alternate provisions EA – A 240 and EA – A 276 since these provisions have now been incorporated in the respective specifications.

LIGHT METALS AND ALLOYS

Tentative Specification for Aluminum-Alloy Round Welded Tubes (B 313 – 57 T)

Revision.—A Section entitled "Cladding Thickness" has been added to this specification by Committee B-7. Although this specification covers a clad product, there was previously no provision for cladding requirements such as appear in other specifications prepared by Committee B-7.

MANUFACTURED MASONRY UNITS

Tentative Specification for Industrial Floor Brick (C 410 – 57 T)

New Tentative.—These specifications cover brick made from clay or shale or mixtures thereof. Ceramic shapes known as quarry tile are not included. The four types of brick covered are (1) type T where low absorption is not required, (2) type H where chemical resistance is a factor and minimal absorption is not required, (3) type M where low absorption is required, and (4) type L where minimal absorption is required and chemical resistance is a factor. A definite need has existed for this standard since there has been no nationally recognized specification for floor brick.

Tentative Specification for Ceramic Glazed Structural Clay Facing Tile (C 126 – 55 T)

Revision.—Changes have been made in this specification so that new ceramic glazes such as the "speckled" glaze will not be excluded from the specification.

Standard Methods of Sampling and Testing Structural Clay Tile (C 112 – 52)

Revision and Reversion to Tentative.—Revised to allow for the use of two materials for capping, namely gypsum and sulfur.

Standard Specifications for Structural Clay Facing Tile (C 212 – 54)

Revision and Reversion to Tentative.—Since both types and classes of units covered in these specifications are suitable for either interior or exterior use, Section 4(*e*) is eliminated which instructs the purchaser to state whether the material is required for interior or exterior use.

Standard Specification for Facing Brick (C 216 – 50)

Tentative Revision.—This revision will permit brick which will pass the freezing and thawing test but not the absorption and saturation coefficient requirements, to be used where SW grade is specified. Provision is also made that color and texture shall be specified by the purchaser and that when type is not specified, the requirements for Type FBS shall govern.

METHODS OF TESTING

Tentative Methods of Test for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials (E 18 – 55 T)

Revision.—Revisions in these methods include the addition of selector charts for Rockwell scales based on approximate hardness and thickness of sheets, and the addition of a definition of Rockwell Hardness Number. Editorial changes are made throughout the document to eliminate long descriptive footnotes by condensing and incorporating them in the text, and Table I has been revamped.

NEW ASTM PUBLICATIONS

The ASTM publications described in these columns have just come off press, and may be obtained from Society Headquarters, 1916 Race St., Philadelphia, Pa.

Compilations of Selected ASTM Standards

Petroleum Products and Lubricants.—Specifications and methods of test developed by ASTM Committee D-2. 1173 pages. Price: $8; to members, $6.

Glass and Glass Products.—Specifications and methods of test developed by Committee C-14. 144 pages. Price: $2.50; to members, $2.

Copper and Copper Alloys—Specifications and methods of test for copper and copper alloys, most of which are under the jurisdiction of Committee B-5 on Copper and Copper Alloys; some are sponsored by Committees B-1 on Wires for Electrical Conductors and B-2 on Non-Ferrous Metals and Alloys. 688 pages. Price: $6.25; to members, $4.70.

Soaps and Other Detergents—26 specifications, 15 methods of test, and definitions developed by ASTM Committee D-12 on Soaps and Other Detergents.

180 pages. Price: $2.75; to members, $2.

Papers on Soils

A wide area of testing and research projects on soils is covered in this publication, ranging from field tests of piles of sand to properties of soil-cement mixtures. The papers were presented at the Second Pacific Area National Meeting in Los Angeles in three sessions arranged by Committee D-18 on Soils for Engineering Purposes. An added feature of the present publication is the address given by Vice-President K. B. Woods at the Soils Industry Luncheon held during the Los Angeles meeting.

Titles and authors of the papers are as follows:

Soil Explorations for Site Selection and Engineering Design—*K. B. Woods*
A Generalized Theory of Soil Resistance—*W. S. Housel*
A Procedure for Separately Evaluating Friction and Cohesion by a Consolidated Direct Shear Test—*L. A. Palmer, P. B. Brown, and C. M. Yeomans*
Experiences with the Consolidation of Pipe Bedding by Vibration on the San Diego Aqueduct—*W. G. Holtz*
The Use of Vibratory Compactors on Granular Base Courses—*C. R. White*
Compaction of Cohesive Soil by Low Frequency Vibration—*F. J. Converse*
Microseismics—*R. K. Bernhard*
Experiences with Electrical Resistivity Surveys on Foundation and Subsurface Investigations in Southern California—*R. A. Maurseth, J. B. Howe, and S. N. Mitchell*
Tests of Concrete Deadman Anchorages in Sand—*J. E. Smith*
Field Tests on Laterally Loaded Piles in Sand and Clay—*H. G. Mason*
Strength and Elastic Properties of Soil-Cement Mixtures—*E. J. Felt and M. S. Abrams*

Special Technical Publication No. 206. 178 pages. Price: $4.50; to members, $3.60.

Papers on Fatigue of Aircraft Structures

Recognizing that fatigue properties of materials and the prevention of fatigue failures in service are a matter of supreme importance to the aircraft industry, ASTM Committee E-9 on Fatigue arranged two sessions of papers specifically for the Second Pacific Area National Meeting in Los Angeles, an aircraft industry center.

Apart from three papers that deal with the fundamental aspects of fatigue, the papers cover various procedures used in the testing of joints and assemblies and the materials entering into them.

Titles and authors of the papers are:

Full Scale Wing Fatigue Testing—*A. R. Vollmecke*
Riveted-Joints Fatigue Strength—*C. R. Smith and G. D. Lindeneau*
The Rehabilitation of Fatigue Weary Structures—*J. P. Butler*
Uni-Directional Axial Tension Fatigue Tests of Beryllium Copper and Several Precipitation Hardening Corrosion Resistant Steels—*M. H. Weisman, J. Melill, and T. Matsuda*
The Effect of Forming on Mechanical Properties—*J. L. Waisman and C. S. Yen*
Fatigue Testing of Airframe Structural Components—*H. W. Foster*

Special Technical Publication No. 203. 95 pages. Price: $2.75; to members, $2.20.

Error in D 349 – 56

A typographical error appears in Section 15 of the Standard Methods of Testing Laminated Round Rods Used for Electrical Insulation, D 349 – 56.

The formula:

$$S = \frac{8WL}{\pi d^2}$$

should be corrected to read:

$$S = \frac{8WL}{\pi d^3}$$

in the following publications:

1. ASTM Standards, 1956 Supplement—Part 6, p. 115.
2. ASTM Standards on Electrical Insulating Materials, September, 1957, p. 216.
3. ASTM Standards on Plastics, February, 1957, p. 121.

ASTM STANDARDS AT WORK

Testing Gasoline or Lard?— Try ASTM Method D 525

A SURPRISING adaptation of ASTM Method of Test for Oxidation Stability of Gasoline (Induction Period Method) is reported in the September issue of *Food Processing*. A variation of Method D 525, an oxygen bomb test is employed as an accelerated test for determining shelf-life of fat-consuming foods. Devised by the Food Laboratories of the Eastman Chemical Products, Inc., the method is said to be faster and more accurate than former methods.

Applied to gasoline, the induction period is used as an indication of the tendency of gasoline to form gum in storage. In its adaptation to a fat—lard, for instance—a sample is placed in the bomb, charged with oxygen at 50 or 100 psi and submerged in a 212 F water bath. An automatic pressure recorder charts progress of the test. Timing starts when an initial peak pressure is reached, ends when a pressure drop of 2 lb or more is observed during two consecutive 15-min periods. Fat is considered rancid at this point.

Annual Meeting Plans Well Advanced

Boston Committee Offers Sparkling Program

PLANS for the 61st Annual Meeting in Boston, June 22–27, 1958, are taking shape as the General Committee on Arrangements goes to work under the leadership of Chairman Miles N. Clair. Preliminary reports from the Finance Committee, under the chairmanship of F. J. Mardulier, indicate that sufficient funds will be available to ensure an entertainment program of sufficient scope to please the entire ASTM family.

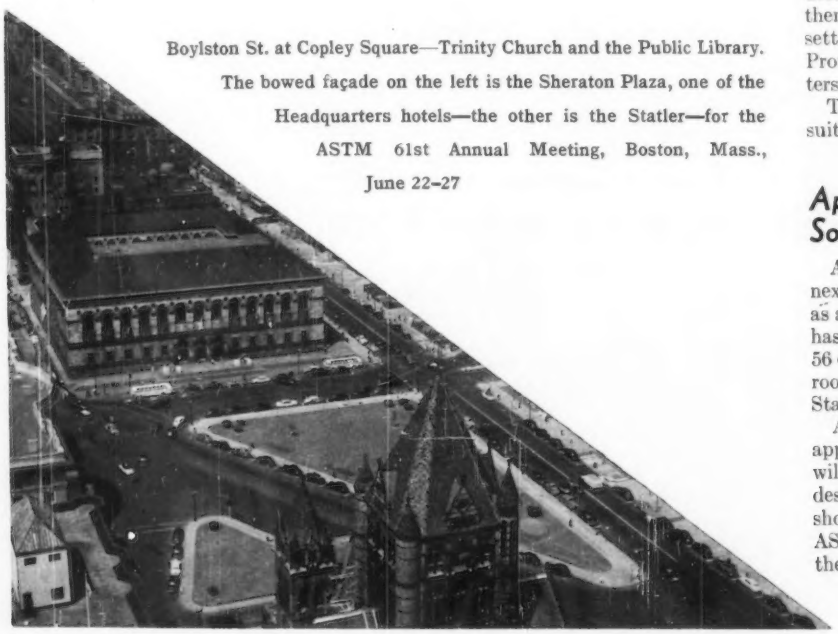
William H. Buracker, Chairman of the Entertainment Committee, has arranged, as the featured entertainment at the Wednesday evening dinner, to have the Boston Pops Orchestra under the direction of Arthur Fiedler at Boston Symphony Hall. Further comment on this world renowned group is unnecessary. While this will be the feature of the week, the other days will not be neglected. Contacts have been arranged at various plants and laboratories throughout the area so that visits may be made if desired.

Mrs. Clair has organized a group of ladies who are planning a full week of opportunities for wives and families of members to visit places of interest, historical and otherwise, in the vicinity of Boston. Perhaps the outstanding item in this category will be a tea and private tour of the famous Gardner Museum—the former house of "Mrs. Jack" Gardner and one of the truly unique museums of the world. Additional social gatherings will assist in making new acquaintances and in renewing old ones.

The subcommittees on Hospitality and Information, under Junius W. Millard, and Transportation under William L. Hyland, are organizing in such a manner that no stranger in town should be lacking for information on where to go and how to get there.

Three or four Industry Luncheons will each feature an outstanding speaker in a particular field. Among the subjects being considered are petroleum, road materials, electronics, plastics, sampling and quality control, and copper and brass.

The General Committee on Arrangements extends a sincere invitation and points out that all members, committee members, guests, and their families have an unusually fine opportunity in the Boston meeting to tie in attendance at the Annual Meeting with a vacation trip to one of the country's most interesting cities in the heart of the East's vacationland.



Boylston St. at Copley Square—Trinity Church and the Public Library. The bowed façade on the left is the Sheraton Plaza, one of the Headquarters hotels—the other is the Statler—for the ASTM 61st Annual Meeting, Boston, Mass., June 22–27

Photographic Exhibit Invitations Out

Members and committee members are reminded that now is the time to initiate work on a prize-winning entry for the 12th ASTM technical Photographic Exhibit. This biennial exhibit has become one of the foremost shows in the country. Entries will be accepted from all members of the Society and from employees of company members. Classes to be displayed are: General, Photomicrographs and Electron Micrographs. Black and white, color prints, and color transparencies will be shown. Special attention will be given to the sections on photomicrography and electron micrography. To be accepted, entries must be informative in their particular technical field.

Students of engineering colleges are especially invited to display their work in metallography and other technical photographic techniques. Membership in ASTM is not a prerequisite to competing as a student.

Each member and committee member has already been sent the necessary application form containing rules for entries accompanied by an invitational letter from E. W. Walsh, Chairman, ASTM Photographic Exhibit. Those desiring extra entry forms may obtain them from E. W. Walsh, The Narragansett Electric Co., 15 Westminster St., Providence, R. I., or ASTM headquarters.

The committee urges everyone with suitable photographs to submit entries.

Apparatus Exhibit Space Sold Out

A successful ASTM Exhibit at the next Annual Meeting is already assured as all of the space for this biennial show has already been reserved. A total of 56 exhibitors will occupy the entire ballroom and ballroom foyer of the Hotel Statler at Boston next June.

A wide range of testing and scientific apparatus featuring new developments will be on display. A more complete description of what each exhibitor will show will be published in the April ASTM BULLETIN, which will feature the program for the Annual Meeting.

ACR Notes

The Problem of Using Available Engineering Knowledge

Administrative Committee on Research

By FRANK T. SISCO[1]

THE CHIEF objectives of the ASTM Administrative Committee on Research are to promote knowledge of engineering materials and to encourage and stimulate research under the auspices of the Society to increase this knowledge. These are worthy objectives and, in my opinion, the Committee is doing a splendid job in its effort to attain them. An important phase in the promotion of our knowledge of engineering materials is making this knowledge available to the engineer who should use it. In this, ASTM, in my opinion, is also doing a splendid job; in its *Book of Standards*, in its *Proceedings*, and its BULLETIN and other publications the Society is publishing annually a large amount of valuable knowledge of materials.

Unfortunately for the individual engineer, ASTM is only one of a large number of professional societies that are promoting knowledge in many engineering fields and which, through their publications, are making this knowledge available to all engineers and research workers. It is not an arduous job for an individual to become familiar with the knowledge of science or technology produced by one society; but for an individual to know what knowledge is available, even in a restricted scientific or technological field, in all of the world's literature is now practically impossible. The amount of literature already in existence and being made available annually to the engineer or the scientist is just too great.

Logarithmic Increase in Volume

In the past twenty or twenty-five years the volume of periodicals dealing with science and technology has increased logarithmically; as long ago as 1952 the Library of Congress received approximately 40,000 scientific and technical journals and other serial publications which contained in that one year 1,500,000 papers. Though this is a very large amount of material, it is probably considerably less than is published today.

To simplify the Herculean job of making technical literature available to the scientist and engineer who should be aware of recent developments in a specific field many excellent abstracting services have developed over the years. These abstracting services are valuable time savers. They also have many faults. There is too much duplication. There are too many omissions. There is too much of a time lag between the publication of the paper and the appearance of the abstract. There is too much confused terminology and there is much bad indexing. Furthermore, I know of no abstracting service in science or in engineering that is self-supporting; increasing the coverage that an abstract journal provides, or increasing the quality of the abstracts, is a virtual impossibility unless additional contributions from an individual, an industry, or a professional society can be secured.

Despite the fact that available abstracting journals leave much to be desired in coverage and in quality, they certainly are better than no abstracting service at all, but the very volume of abstracts available—for example, 27,000 abstracts in 1956 in *Engineering Index*, 5100 in the *Journal* of the Iron and Steel Institute, 7600 in the *Journal* of the Institute of Metals, 8400 in the *Metals Review*—makes it a labor, also worthy of Hercules, to go over them in order to keep abreast of recent developments. And it should not be forgotten that only a fraction of the available literature (probably less than 25 per cent) is abstracted in any one year.

A Job for the Librarian?

When I have mentioned this problem to my peers the answer has invariably been: "This is a job for the librarian, who should be able to supply a reader with the information he needs." This is a correct answer in the case of technical and scientific books. A modern library invariably has its books excellently indexed and classified, and, if it is an efficient library, the staff can supply a reader with almost any book in their collection in a comparatively short time. But books are not what the engineer needs; he needs the periodicals, and for periodical literature this capability does not hold. No library, so far as I know, has the available staff, either in numbers or in skills, to index and classify periodical literature so that they can be delivered to the specialized reader on demand, or even in a reasonable time. Most libraries have all of the important abstract journals, but these are not adequately indexed; nor are they logically classified, hence the only way in which an engineer or research worker can find out what is in the periodicals literature is to dig it out for himself.

Twenty-five years ago this was not an impossibly difficult job; the engineer or research worker could start with a recent summary paper and with a number of informative abstracts in his selected field and by means of the bibliographies appended to the papers he could follow the literature back as far as he considered it necessary to go. This was not a job for the librarian; it was a job for a technically trained man who could select the pertinent published data and correlate it, thus providing himself with the proper background of knowledge to begin his own research program. A large number of young scientists and engineers obtained a valuable and lasting knowledge of a specialized field in this way.

Furthermore, engineers as a class are conscientious and ethical individuals; not only do they consider it necessary to know what has been done in a specific field before beginning a research job or before developing a new product or process—to save the time and labor in repeating work already done—they also seldom fail to credit other workers in the field by referring in the text to the previous papers which are listed in a bibliography appended to their own report or technical paper.

Today, reviewing the literature, even in a restricted field of engineering, is difficult and time-consuming; so much so, in fact, that in many laboratories it is considered easier and less costly to do a research job than to attempt to find out whether it has been done previously by someone else and reported in the literature.

The problem of locating the great store of engineering knowledge already available and of coping with the flood of new knowledge appearing in the literature each year is one that should concern every member of every engineering society, including ASTM and its Administrative Committee on Research.

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[1] Director, Engineering Foundation, New York, N. Y.

Resolutions to Implement National and Inter-American Standards

ASTM Represented in American Delegation

At the five-day Inter-American Conference on Standards held at Rio de Janeiro, Brazil, September 23–28, in which twelve nations participated including the United States, a number of important resolutions and actions were approved to expedite and implement the formulation of national and inter-American standards. Representing the ASTM as part of the seven-man USA delegation were national Director A. Allan Bates, vice-president, Portland Cement Assn., who had earlier lived in Brazil, and Executive Secretary Robert J. Painter.

Background and Purpose

This inter-American meeting of experts on standards was developed under the auspices of the Inter-American Economic and Social Council of the Organization of American States.[1] Actually, the Rio conference resulted from a recommendation of the Finance Ministers of the various states urging that studies be made to prepare a code of technical standards, common to the American countries, which might serve as a basis for governing trade in principal raw materials and semimanufactured products.

There are really two independent activities going on: one, the work of the Committee on Economic Cooperation which had prepared a document involving the code of technical standards, and the other, an independent activity called the Pan American Standards Committee which included representatives of six countries which have national standardization organizations.

The objective of the Rio conference was to consider the development and adoption of standards and specifications at a national level, on an inter-American level, and to consider technical assistance.

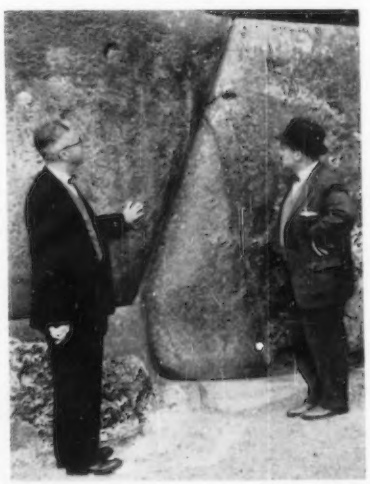
While the Brazilian and United States delegations were by far the largest at the conference, there was a free interchange of opinions and comments and all of the states participated in the working committee that was established. Countries represented included the following:

Argentina	Mexico
Brazil	Nicaragua
Colombia	Panama
The Dominican Republic	United States
El Salvador	Uruguay
Honduras	Venezuela

Representatives of technical organizations in Bolivia and Chile were also present.

Organization—Harmony

The President of the conference was Dr. Luiz Simoes Lõpes, distinguished official of the Brazilian government, and head of the working committee was Dr. Paulo Sá, Director of the Brazilian Standards Assn. (ABNT). This latter organization, which is to a considerable extent based on the ASTM type of organization as indicated by Dr. Sá during one phase of the conference, handled the recording of the minutes and resolutions and cooperated with the representatives of the OAS who did an excellent job in the translation on the spot, and in writing, from Portuguese into English and *vice versa*.



Executive Secretary R. J. Painter and National Director A. Allan Bates, inspecting the joints and the huge stones making up the famous Inca Sacsuahuaman Fortress above Cuzco during the S. A. trip. The joints between the huge stones are so precisely formed that it is not possible to insert a knife blade in many of them. No mortar was used.

As stated by the chairman of the American delegation, Dr. Archibald T. McPherson, associate director, National Bureau of Standards, "The conference as a whole was marked by an unusual degree of unanimity in thinking and the relations among the various delegations were most cordial and friendly." One general statement which involved a fundamental principle for the formation of national standards organizations was quite thought-provoking in that a U. S. statement drafted on the first day and another by the Argentine representation were very similar. They involved the concept that a standardizing institution should be based on voluntary participation of the producing, using, and general interest groups, and government represented by technical men and women from such groups as manufacturers, trade associations, distributors, technical societies, educational institutions, and the government. The U. S. statement recommended that where it was necessary for national bodies to be set up within the government itself, these should provide for maximum participation of all groups and that it should be the objective to transfer the work to private organization control as soon as private enterprise could administer and finance the operation.

Some Recommendations

Emphasis was given at the conference to the importance of having competent laboratories to insure compliance with standards.

Specific recommendations included the preparation of a glossary of four language equivalents of technical terms (Portuguese, Spanish, French, and English) and a comprehensive program for the translation of standards.

In general, the conference looks to the Pan American Standards Committee as an agency to carry out its recommendations but urges that it be reorganized,

[1] The OAS stems from the first conference of American states which met in Washington in 1890. It comprises the 21 republics of the western hemisphere and is actually an agency within the United Nations. Its aims are to promote peace and justice and the solidarity of the American states and to strengthen their collaboration. Each state designates an official ambassador. The general secretariat and central organ is the Pan American Union. There are several departments including those for Economic and Social Affairs, International Cultural Affairs, and Administrative Services. The Rio conference on standards was part of the work of the Department of Economic and Social Affairs.

expanded, and invigorated. One thought is that the PASC become a truly inter-American standards committee so that *all* American states would participate—not merely the six that now have national bodies.

Translations

Concerning translations, the conference recommended that the member states be urged to give all possible help in translating technical standards into the four languages and that the Pan American Standards Committee be asked to indicate the priority of standards most needing translation, with the economic branch of the Organization of American States doing what it can in the shortest possible time to implement translation.

Metric System

Another matter discussed at some length was the metric system. While the United States delegation was quite cognizant of the great importance of this system to the Latin American countries, it refrained from voting on the resolution that the Economic and Social Council of OAS point out the advantages of the metric system to those states not now using it and to promote the publication of tables of conversion factors. The chairman of the U. S. delegation noted that we cannot readily change our present units of measurement but that compromises could be made to facilitate interchangeability of parts, such as the fixing of certain preferred dimensions.

A number of other resolutions related to methods for statistical techniques, quality control, problems of collaboration between the states, permanent activities, etc.

It is hoped that the various resolutions and proposals can be studied and implemented without great loss of time. Certainly a more effective instrumentality for inter-American standards work is needed. It is believed that everyone at the conference is in agreement on this point, and to assist in this direction it is the thought that the American delegation informally will arrange conferences with appropriate officials and offer to assist in carrying through.

The personnel of the American delegation was as follows:

Archibald T. McPherson, *chairman*	Willis S. MacLeod
Cyril Ainsworth	Robert J. Painter
A. Allan Bates	Richard C. Sogge
Edwin W. Ely	Vincent E. Bower (Observer)

Several of these men later went to Sao Paulo for other contacts and attended the meeting of the ASTM members there.

Messrs. Bates and Painter are impressed with the tremendous upsurging economy evident in so many of the South American countries. Unique uses of concrete, construction of all kinds evident almost everywhere, growing recognition of social responsibilities, desire to cooperate among the various states and engineering societies—these are some of the impressions. No one becomes an authority on a big continent in a three-weeks' stay; and yet all that the national officers saw adds up to a picture of a great continent which will make tremendous strides forward in the next decade or two.

What further part the United States will play in this remains to be developed. Commercial competition is keen. Our friends from other parts of the world are anxious to participate in the commercial and industrial growth. Competition is good, and it is evident in many areas in South America.

Luiz D. Villares, at Copacabana Beach, Rio, with Sugar Loaf in background. A leading South American industrialist and ASTM member, Senor Villares was host to the national officers on their trip to Rio.

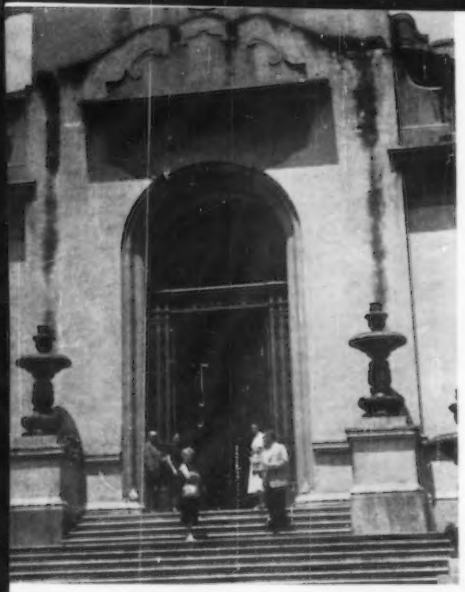
National Officers Meet South American Members; Find Engineers and Industrialists Vitally Interested in ASTM

Intense interest in the field of materials and particularly in the work of ASTM research and standards for materials was very evident at meetings held with our members in such industrial centers as Rio, Sao Paulo, and Caracas during the recent trip of National Director A. Allan Bates, Portland Cement Assn., and ASTM Executive Secretary Robert J. Painter. The two officers began their trip in Rio attending the Inter-American Conference on Standards called by the Organization of American States. They were official delegates, part of the American Delegation of seven appointed by the State Department, which met with representatives of many of the other American states.

Messrs. Bates and Painter were very pleased to meet for the first time a number of ASTM members who are leading engineers and industrialists in this burgeoning continent. Dinners were held in Sao Paulo, Brazil, and in Caracas, Venezuela, the centers of the greatest concentrations of members, and in Rio, the site of the Standards Conference. (See opposite page.)

Among the subjects discussed at these ASTM meetings was the desirability of publishing standards in Portuguese and Spanish. There were two schools of thought, one that any such activity, whether carried out under the auspices of an inter-American group or by the Society, should start with selected groups of standards, those that are most widely used, and to make them available in *both* Portuguese and Spanish. Another comment was that South America, with its tremendous growth, sooner or later will have a use for all of the standards, for example, in the ASTM Book of Standards, and it would not be amiss, therefore, to plan, say with the 1958 edition, to have the entire 1958 edition

At the yacht club, Santos, left to right, Mrs. R. J. Painter, Mariano Ferraz, managing director, Cia. Sorocabana de Material Ferroviario, president of the Brazilian Standards Assn., and Senora Ferraz. Senor Ferraz, an active ASTM member was host to the national officers in Sao Paulo.



The party at Caracas' famous Pantheon. Within this impressive building lie the remains of Simon Bolivar, fabulous South American Liberator. In the party are S. J. Mathis, Sr., Creole Petroleum Co., and Mrs. Mathis.

AT MEETINGS IN SOUTH AMERICA WERE:

RIO DE JANEIRO DINNER

Terence Ivey, Co. de Garris, Luz E. Farca do Rio de Janeiro
E. D. Difini, Refinaria de Petroleos De Manguinhos S.A.
C. D. Moura, Conselho Nacional de Petroleo
Roberto Sussekind, Brazilian Telephone Co.
A. P. Albuquerque Neto, Civil Engineer

SAO PAULO DINNER

Luiz Dumont Villares, Acos Villares S.A.
Luiz D. Villares, Jr.
Edwin W. Ely, U. S. Dept. of Commerce
Mariano Ferraz, Cia Sorocabana De Material
A. T. McPherson, National Bureau of Standards
A. F. Torres, Associaco Brasileira De Cimento Portland; Professor, Sao Paulo Escola Politecnica
V. E. Bower, National Bureau of Standards
Felix Baldass, Cimento Santa Rita S.A.
Flavio Cardoso, Asfaltos California
Walter Christian, Philips Do Brazil
J. H. Smith, Caterpillar Brasil S.A.
M. A. Teixeira De Castro, Consulting Engineer
Souza Santos, I P T
E. L. Berlinck, Associacao Brasileira De Normas Tecnicas
Frederico Smolka, Esso Standard
C. E. Paes Barreto, Uniao Refinery
W. A. MacLeod, General Service Administration

CARACAS DINNER

A. P. M. Middlekoop, Cia Shell de Venezuelo
John G. Dempsey, Compania Anonima de Concreteo
Philip Ellison, Shell Co.
Marcelo Gonzalez, Universidad Central
Ramon Espinal, Universidad Central
S. J. Mathis, Creole Petroleum Co.
Jose R. Silva Cadeno, Compania Anonima Venezolana de Cementos
Jose Sanabria, Creole Petroleum Corp.
E. V. Barrett, Guave & Barrett, C.A.
R. L. Kimmons, Creole Petroleum Co.

BUENOS AIRES RECEPTION AND DINNER

Host: Instituto Argentino de Racionalizacion de Materiales
Antonio Aguirre and Wife, president, A. P. Green y Cia; General Delegate of the American Chamber of Commerce
Claude Merrell and Wife, president, National Lead y Cia; president of the American Chamber of Commerce
Nestor J. Ottonello and wife, civil engineer; president, Comision Nacional de Uniformacion de Materiales
Francisco I. Stewart and Wife, president, Instituto Argentino de Racionalizacion de Materiales
Carlos A. Abeledo and Wife, Gerente de Monsanto Atanor, and first vice-president, IRAM.
J. F. Garcia Balado, technical director, Instituto del Cemento Portland Argentino, and second vice-president, IRAM.
Miguel F. Ciaburri and Wife—Beatriz Ghirelli de Ciaburri. She is director general, Instituto Argentino de Racionalizacion de Materiales

translated and published. While the cost of this would run into several hundred thousand dollars, there are those in both the United States and Latin America who think that it would be a very constructive and forward-looking move. ASTM standards in the field of refractories and others have already been translated into Spanish.

It is of interest that U. S. companies that have branches in South America have translated into Portuguese or Spanish many of their own company standards and also national specifications or standard tests.

There is probably no meeting of engineers from different countries, particularly those which have strong ties with Europe, where there is not a discussion of the metric-English unit system. Both at the Rio standards conference and in meetings of ASTM members this was reviewed. Obviously it is a very involved problem. Here in the United States 170 million people are wedded to our American system of units, our standards are in general based on it; our weaponry for defense is tied in inextricably with the American system. And yet considering the great potential growth in South America and their unalterable link to the metric system, more thought might be given to constructive actions which would tie the systems together more conveniently. For example, dimensions selected for testing or laboratory equipment are frequently somewhat empirical. They might be chosen so that they could more easily be converted to the metric units.

A few years ago the Argentine oil fields, a branch of the Government, did translate into Spanish virtually all of the ASTM methods and standards covering petroleum. In so doing the conversion was made both in the text and in the diagrams to the metric system. As far as we know there was no great problem in this rather ambitious probject.

The officers noted with pleasure the desire on the part of these groups to meet again and perhaps gradually develop regular get-togethers so that the members could meet one another to discuss problems of common interest and to consider ways and means of promoting interest in ASTM and its work.

Meeting with Argentine Standards Officers

In Buenos Aires the officers and their wives were honored at a reception and dinner at which were present the national officers of the Argentine standards organization, IRAM, Instituto Argentino de Racionalizacion de Materiales. At the Rio conference the officers had met Señora Beatriz Ghirelli de Ciaburri, executive director of the Association, and the chief of the delegation, Nestor J. Ottonello, prominent Argentine engineer and president of the

On the balcony of the Gloria Hotel, Rio de Janeiro, with Botofogo Bay in background. From left to right, F. V. De Miranda Carvalho, Executive Secretary R. J. Painter and J. Nestor Ottonello, prominent Argentine civil engineer, chairman of Argentine Delegation to Rio Conference, chairman of the Commission and honorary secretary, B. A. Rotary Club.

National Commission for Standardization of Materials (he and the ASTM Executive Secretary are fellow Rotarians). Among those present were Vice Admiral Francisco I. Stewart, president of IRAM, and Claud Merrill, president, National Lead Co. in Argentina and president of the Argentine U. S. Chamber of Commerce. Others are shown in the accompanying list.

The society is fortunate in having as members and friends some of the continent's leading industrialists and educators. In Sao Paulo and Brazil, Messrs. Mariano Ferraz, Luiz Dumont Villares, and Dr. Ary Torres are very prominent in the industrial life of this community. In addition, Mr. Ferraz is president of the Brazilian Standards Assn.

In Caracas, in the absence of G. A. McCammon, one of our members in perpetuity, his associate, S. J. Mathis, Sr., Creole Petroleum Co., arranged the dinner and meeting and took the visitors on a complete tour of the city. To these men and others in Rio and elsewhere, the national officers are grateful for their many courtesies. With their help and guidance it was possible in a short time to do many things—to visit industrial plants and the ports of Santos, to have a quick view of Buenos Aires, to attend Rotary functions, one of which heard a very pertinent description of ASTM given by a Sao Paulo engineer, Gustavo Borghoff, to the some 60 business men present, a quick but rather thorough trip through and around Caracas—were all sandwiched in the three-week period. That so much could have been done and seen is largely because of the wonderful reception given the national officers by the members and friends in South America.

At least one of the men, Mr. Ferraz, will be in attendance at the Boston Annual Meeting and it is hoped a number of other members from Latin American countries can attend to meet their fellow members in the United States.

Executive Secretary Robert J. Painter would be much interested in knowing of any ASTM members from the U. S. who may be going to Latin America for a period with the thought that meetings of our members might be arranged.

HEADQUARTERS WELCOMED...

Vladimir Korenic, Secretary of the Federal Commission for Standardization of Yugoslavia, and two of his associates, **Jefta Jeremic** and **Branislav Sikic,** who visited ASTM Headquarters the afternoon of October 21. The group is visiting the United States under the auspices of the International Cooperation Administration to study American methods of forest management, administration, and organization. They are particularly interested in the research and standardization work of ASTM on wood and related materials.

Philippine Industry Standardization Study Team, eight Philippine representatives of government and industry organized by the Philippine Standards Assn. and sponsored by the Industrial Development Center under the economic development program of the Philippine National Economic Council and the United States International Cooperation Administration. The group is studying industrial standardization methods in the United States, Great Britain, Japan, and certain areas of Western Europe.

The members of the group, upon their return to the Philippines, will submit to the Industrial Development Center a comprehensive report on their study and observations abroad. They will also recommend and help organize the most practicable system of standards implementation to be adapted to Philippine conditions and lead toward making Philippine standards effective and a stimulant to foreign trade.

Heavy Forgings Group. See photo below.

This group of 65 leading experts on heavy forgings for turbines and generators includes about 28 metallurgists and scientists from over the seas. Countries represented in addition to the United States included France, Germany, Great Britain, Italy, and Liechtenstein. Most of these men were attending the World Metallurgical Congress held in Chicago. This meeting was arranged by the Section on Brittle Fracture of Forgings which is a part of Committee A-1 on Steel's Subcommittee 6 on Steel Forgings and Billets. A. O. Schaefer, of Pencoyd Steel and Forge Co., heads both the section and the subcommittee. ASTM Past President Norman L. Mochel, manager, metallurgical engineering, Westinghouse, served as program chairman of the meeting at ASTM Headquarters on November 11. Papers and discussions were presented by representatives of General Electric, Westinghouse, Allis-Chalmers, Bethlehem Steel Company. The group had lunch at the nearby Hotel Sheraton and dinner at the Barclay Hotel. This committee is making progress in its studies of some of the perplexing problems concerning the homogeneity of steel forgings.

ASTM Bulletin

DECEMBER 1957

NO. 226

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

Many New Members from Overseas; Biggest Help in Growth Is Members' Interest

Larger Membership Means Wider Use of Standards

THE STEADY growth of our membership overseas is interesting and significant. One has only to review the list of new members published in each issue of the ASTM BULLETIN, which is arranged according to geographical location to recognize that a good percentage of the new members is from countries beyond the oceans.

For example, a perusal of recent groups of membership application blanks showed members in various classifications such as consulting engineers, construction, universities, etc., coming from such countries as Belgium, China, Colombia, Egypt, England, France, Germany, India, Israel, Peru, Sweden, Switzerland, Uruguay, and Venezuela. While the Staff and National Officers will meet some of our overseas members occasionally, and we are always pleased when they can stop in at Headquarters as some do from time to time, our contacts with these men and organizations are for the most part by letter and publications.

Some city not on the North American continent is "home" to about 1000 ASTM members.

Recently two of the officers on a South American trip were privileged to meet many members there and they confirmed our longtime knowledge that whether in the States or overseas the members find the publications and services very helpful.

Our answer always to the question "Why do you want more members," emphasizes that each new member is a potential user of our standards, thus promoting industrial efficiency and increasing the advantages that come from the results of the extensive work of thousands of our committee members; new members, of course, find the technical data in our *Proceedings* and technical publications worth while and some are contributing to these storehouses of information.

Naturally, we always point out too that the financial and other support of the Society is necessary and justifies promoting a steady membership growth. Recently the Long-Range Planning Committee and the Board of Directors reviewed briefly our membership curves, and, while there is some concern that our percentage representation of the total number of engineers and scientists is not at the percentage level prior to the war, nevertheless the gains are stimulating, and considering our different membership classes, sustaining and company as well as individual, we should not be too pessimistic.

Currently, our membership tops 9150. Of these almost 3000 are company or sustaining members. Then we must always acknowledge the interest and help of more than 5500 leading technical men who are themselves not affiliated with the Society but who through representation of their companies and other organizations are on our hundreds of technical committees and contribute greatly to our work of research and standards for materials.

One fact remains paramount and has through the years, namely, that the biggest and best source of new members and the greatest help in membership promotion is the active interest of so many of our current members. Hundreds of our members keep in mind the value of ASTM membership and urge their friends and associates to join, others endorse application blanks and assist in various ways. All this the officers appreciate.

OFFERS OF PAPERS FOR 1958

THE Administrative Committee on Papers and Publications will meet in early February to consider the papers to be published by the Society in 1958 and to develop the program for the Annual Meeting to be held in Boston, June 22–28.

All those who wish to offer papers for presentation at the meeting and publication by the Society should send these offers to Headquarters *not later than January 10, 1958.*

All offers should be accompanied by a summary which will make clear the intended scope of the paper and will indicate features of the work that will, in the author's opinion, justify its publication and inclusion in the Annual Meeting program.

Suitable blanks for use in transmitting this information will be sent promptly upon request to Headquarters.

1958 Nominating Committee

IN ACCORDANCE with the By-laws providing that the Board of Directors shall select a nominating committee of officers, the Board has considered the report of the tellers—J. C. Geniesse and L. J. Minnick—recommending members of the nominating committee, and has appointed the members shown below.

Serving on the 1958 Nominating Committee as *ex officio* members are the three immediate past presidents: N. L. Mochel, C. H. Fellows, and R. A. Schatzel. The committee will meet in February and will nominate for the offices of president, vice president, and directors (5). The selections will be announced to the members in the ASTM BULLETIN prior to transmission of the official ballots.

Members	Alternates
W. C. Hanna, Calif. Portland Cement Co.	W. H. Price, U. S. Bureau of Reclamation
J. B. Rather, Jr., Socony-Mobil Oil Co.	W. E. Scovill Standard Oil Co. (Ohio)
W. Babington, Bell Telephone Labs.	C. H. Sample, The International Nickel Co.
Edwin Joyce, (retired) American Petroleum Inst.	C. F. Lewis, Cook Heat Treating Co.
H. C. Larson, Bethlehem Steel Co.	C. L. Kent, Jones & Laughlin Steel Corp.
C. H. Adams, Monsanto Chemical Co.	H. K. Nason, Monsanto Chemical Co.

Satellites—and ASTM

To PRESENT a composite of the thinking of our members on the satellite or armament race would be very difficult, and we do think it rather pointless to obtain such information. We feel that the general philosophy underlining the Society's extensive work for various branches of the Government including the Departments of Defense in World War II, which brought the Society the Army Ordnance Distinguished Service Award and the United States Navy Certificate of Achievement, is still sound.

In essence this is to continue our research and standards in materials as aggressively as we know how, and wholeheartedly to offer our services in the field of materials to the Government. Various Government branches avail themselves of our services on numerous occasions. Our advances in research and standardization since World War II have been greater than in any like period in the Society's history.

In connection with the satellite situation and the armament race, much of which probably boils down to scientific progress, we like the statement by Walter J. Murphy, editorial director, applied journals of the American Chemical Society, in *Chemical and Engineering News* under the heading, "Satellite—Bane or Blessing." He writes in part:

> For years this publication and many other spokesmen for science have urged that a Department of Science be established, headed by a Cabinet member. Congress has been urged to set up an advisory committee of distinguished scientists to help nontechnically trained legislators cope with the needs of an age when science plays a vital role in our lives and, indeed, can possibly effect our annihilation.
>
> So far these suggestions have been unheeded. What we need is a statesmanlike approach and a sound program designed to maintain this country in a status at least equal to any other in the field of scientific research. Action, and not partisan recrimination, will bring results. But it must not be delayed too long. However, this is no time for hysteria.

We might add—it is a time for work.

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

Date	Group	Place
Jan. 13–15	Committee D-19 on Industrial Water	New Orleans, La. (Hotel Jung)
Jan. 23	Southern California District	Los Angeles, Calif. (Rodger Young Audit.)
Jan. 27	New Mexico Meeting	Albuquerque, N. M. (University of New Mexico)
Jan. 28	Committee D-21 on Wax Polishes and Related Materials	New York City (Park-Sheraton Hotel)
Jan. 28–30	Committee B-5 on Copper and Copper Alloys	New York City (Sheraton-McAlpin)
Jan. 30	Northern California District	San Francisco, Calif.
Jan. 31	Committee D-25 on Casein and Similar Protein Materials	New York City (ASA Headq.)
Feb. 3	Southwest District	Houston, Texas
Feb. 2–7	Committee D-2 on Petroleum Products and Lubricants	Houston, Texas (Rice Hotel)
Feb. 10–14	**ASTM COMMITTEE WEEK**	**ST. LOUIS, MO. (HOTEL STATLER)**
Feb. 18	Philadelphia District	Philadelphia, Pa. (Franklin Inst.)
Feb. 20–21	Committee D-6 on Paper and Paper Products	New York City (Hotel Commodore)
Feb. 24–26	Committee D-20 on Plastics	Pittsburgh, Pa. (Penn-Sheraton Hotel)
Feb. 25	Committee B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts	Washington, D. C. (Mayflower Hotel)
Feb. 26–27	Committee F-1 on Materials for Electron Tubes and Semiconductor Devices	Washington, D. C. (Mayflower Hotel)
Feb. 26–28	Committee D-9 on Electrical Insulating Materials	Pittsburgh, Pa. (Penn-Sheraton Hotel)
March 3	Committee E-13 on Absorption Spectroscopy	Pittsburgh, Pa. (Penn-Sheraton Hotel)
March 5–7	Committee D-1 on Paint, Varnish, Lacquer and Related Products	Louisville, Ky. (Kentucky Hotel)
March 5–7	Committee C-16 on Thermal Insulating Materials	Hollywood, Fla.
March 18–21	Committee D-13 on Textile Materials	Washington, D. C. (Sheraton Park Hotel)
March 25	Committee E-12 on Appearance	Washington, D. C. (National Bureau of Standards)
March 26–28	Committee D-15 on Engine Antifreezes	Washington, D. C. (Shoreham Hotel)
April 1	Committee C-3 on Chemical-Resistant Mortars	Philadelphia, Pa. (ASTM Headquarters)
April 10–11	Committee C-23 on Sorbent Mineral Materials	Detroit, Mich. (Hotel Statler)
May 26–27	Committee D-10 on Shipping Containers	New York City (Hotel Statler)
June 2–6	Committee E-14 on Mass Spectrometry	New Orleans, La. (Hotel Jung)
June 22–28	**ASTM ANNUAL MEETING**	**BOSTON, MASS. (STATLER AND SHERATON PLAZA HOTELS**

Reliability and Quality Control Symposium Opens January 6

ASTM, through its Committees A-6 on Magnetic Properties and F-1 on Materials for Electron Tubes and Semiconductors will participate in the Fourth National Symposium on Reliability and Quality Control to be held January 6 to 8, 1958, at the Statler Hotel, Washington, D. C. It is expected that 50 authorities in the field will present papers on the techniques used in obtaining reliable equipment and the management aspects of such programs. Papers will cover problems similar to those related to recent missile firing failures and efforts to control such failures.

Cooperating societies include Institute of Radio Engineers, American Society for Quality Control, American Institute of Electrical Engineers, Society for the Advancement of Management, and American Statistical Assn.

Inquiries should be addressed to:

W. H. Rombach
Philco Corp.
4700 Wissahickon Ave.
Philadelphia 44, Penna.

Papers on Mass Spectrometry

THE Sixth Meeting on Mass Spectrometry, sponsored by ASTM Committee E-14 will be held at the Jung Hotel in New Orleans during the week of June 2, 1958.

Papers are welcome on all phases of mass spectrometry. A symposium on ion-molecule reactions has definitely been arranged. Abstracts of papers believed suitable for presentation should be in the hands of one of the co-chairmen of the Subcommittee on Programs and Papers by February 1, 1958:

R. A. Friedel or
A. G. Sharkey, Jr.
U. S. Bureau of Mines
4800 Forbes St.
Pittsburgh 13, Penna.

District Activities

NEW ENGLAND

Student Awards Honor Lester

THE New England District presented its inaugural H. H. Lester Memorial Student Awards at a meeting held on October 31, at the M.I.T. Faculty Club in Cambridge. The students were presented by Albert Haertlein of the Graduate School of Engineering of Harvard University. President Kropf gave the students their award certificates.

Among the recipients were the following students: Edward T. Sahlin, University of Connecticut; John Holbrook King, Yale University; Myron M. Thayer, University of Massachusetts; Bruce Nelson MacIver, Northeastern University; Sanford Millard Nobel, Massachusetts Institute of Technology; Arthur Tracy, Lowell Technological Institute; D. J. Ripple, Worcester Polytechnic Institute; Max Comolli, University of New Hampshire; Richard D. Bugbee, Dartmouth College; Robert E. Charpentier, University of Rhode Island; David B. Peterson, Brown University; Joseph L. Stockwell, University of Vermont; Edward K. Davies, Norwich University.

Roger J. Coe, vice president of Yankee Atomic Electric Co., followed the exercises with a talk on "Atomic Power for New England." Mr. Coe, in a slide-illustrated lecture, gave a capsule review of the progress his company has made toward generating commercial quantities of electricity from atomic power. The initial period of his discussion was devoted to a survey of methods available for controlling atomic reaction. A detailed description of typical reactors was also given.

The second portion of the lecture was devoted to the specific design problems and material problems associated with the Yankee Atomic Plant. A model of the plant, which is designed to produce 134,000 kw, was also shown.

SOUTHWEST

Marburg Lecturer Talks on Industrial Water

The technical aspects of industrial water were discussed at a joint meeting held on November 11, in Houston. Everett Partridge, Director of the Hall Laboratories and 1957 Marburg Lecturer, addressed the session. The program was arranged through the cooperation of the Texas Society of Professional Engineers, American Institute of Chemical Engineers, American Chemical Society, National Association of Corrosion Engineers, and the American Society of Civil Engineers.

President Kropf at New Orleans

A meeting in New Orleans was held under the auspices of the Southwest District, but handled largely by the staff of the Southern Regional Research Laboratory, U. S. Department of Agriculture in New Orleans. There are a number of active ASTM committee members there and the meeting on November 19 at which President R. T. Kropf was the speaker was held at the Laboratory, followed by an informal dinner at Arnaud's.

The President was able to greet a number of old friends who had worked with him on Committee D-13 on Textile Materials. G. E. Goheen, assistant director of the Laboratory, arranged for the technical session where the President was introduced by Carl Conrad. The dinner, handled by Cecil Shilstone, partner, Shilstone Testing Laboratories, provided an opportunity for a number of members and visitors to get better acquainted and discuss things of mutual interest.

President Kropf's talk dealt with "Economic Evolution vs. Textile Research: A Challenge." Since this may be reprinted or extensively abstracted in the BULLETIN, only a few notes appear here. In tracing the economic evolution, he cites the tremendous increase in the use of iron per capita per annum. Plotted as a log scale this shows an increase per year of about 1.6 per cent compounded—a tremendous increase.

However, in the case of textiles the increase has been 1.6 per cent but on a linear base. Then he notes a number of factors including the problem of production and suggests that a strong emphasis on innovation, automation, and motivation may provide at least partial solution for the current doldrums of the textile industry. An increase of only a pound or two per capita in textile fibers would mean the difference between coasting and providing a desirable cushion from which increased wages, reserves for capital expenditures, and dividends can be provided.

The head table at the joint meeting of the Southwest District in Houston. T. M. Keiller, president of the Texas Society of Professional Engineers is at the rostrum. On his left are the speaker, E. P. Partridge, director, Hall Laboratories; ASTM District Councillor E. E. Berkley, Anderson, Clayton & Co.; and C. L. Fitzgerald, Jr., American Institute of Chemical Engineers. Second from left is J. T. Payton, National Association of Corrosion Engineers.

WESTERN NEW YORK-ONTARIO

Cave Man to Space Man via K.O.M.

President Kropf, addressing the Western New York-Ontario District meeting on November 11, posed many questions in his talk "Cave Man to Space Man Via K.O.M." which provoked a lively audience discussion.

After stressing the value of knowledge of materials through the Stone, Bronze, and Iron Ages, Mr. Kropf cited data on the use of materials and their requirements which will carry us into the Rocket Era. Developing his discussion from past information and expert predictions of future needs, he demonstrated that there would be a critical need for food, energy, and scientific brainpower. Questions concerning our material references and the necessary extensive revitalization of our scientific education program were introduced by President Kropf.

One point brought out in the discussion was the conservation of scientific manhours by the use of standardized procedures. It was felt that extensive education of consumers and government agencies to this value of ASTM standards should be undertaken.

Clarence Lamoreaux, Buffalo Slag Co., Chairman of the district, was host for the meeting and reported that the district had definite plans to make at least thirty student recognition awards at its spring meeting. This will be the initial step taken by the district in this program.

Robert Painter, Executive Secretary, briefly outlined steps now being taken by the Long Range Planning Committee to prepare the Society for the next decade of growth. He congratulated the Western New York District for its entry into the Student Award Program and emphasized that this program was one of the best possible activities a district could undertake since it benefited not only the students but also the schools and the society.

PITTSBURGH

The Difficulty in Strength-Testing Brittle-State Materials

Winston Duckworth, chief of Ceramic Division, Battelle Memorial Inst., speaking before a joint meeting of the Pittsburgh District of ASTM and the Pittsburgh Section of the American Ceramic Society on November 12, discussed in great detail the difficulties encountered in conducting strength tests on brittle-state materials. Introduced by C. Burton Clark, Harbeson Walker Refractories, chairman of the ACS Section,

C. Burton Clark, chairman of the joint Pittsburgh District meeting and Winston Duckworth, the speaker.

Dr. Duckworth opened his remarks with a description of the failures possible in ceramic materials and their causes.

The ratio of tension to shear stress, it was postulated, determines whether the material will have a ductile or brittle behavior. There are five external factors which affect the apparent strength properties, particularly under test conditions. These include loading rate, temperature, notches, distribution of, load, and external stresses.

The actual preparation of ceramic materials is substantially affected by the severity of firing. Data showed decreased porosity and increased crystal size caused by prolonged firing. Optimum strength results were obtained at the lowest porosity and at the minimum crystal size compatible with this porosity.

The usefulness of present testing methods appears to be limited to a comparison of materials possessing the same magnitude of strength. One important difficulty presently encountered is the size effect. The classic explanation of this phenomenon is that failure possibilities are a function of the number of imperfections and the latter is proportional to volume.

The statistical approach to the relationship between strength in torsion and brittle failure, evolved by Weibull, has given excellent correlations. However, considerable research remains to be done. Dr. Duckworth concluded his remarks with a rapid coverage of the present state of bend and compression testing.

A lively discussion ensued with questions from the audience concerning glass, ductile magnesia, photostress methods, and electrical failure.

DETROIT

Transistor Prowess Demonstrated

Robert Ryder, Bell Telephone Laboratories, addressing the Detroit District, on November 13, at the Engineer Society Building gave a remarkable demonstration of the amplifying capabilities of semiconductors, in particular, transistors. Mr. Ryder described the three current classes of transistors, namely, grown juncture, alloy juncture, and diffused base transistors. Highlighting his talk with slides and working models, he brought the audience through the sequence of purifying raw materials the manufacture of transistor wafers, and assembly and application.

The materials used, germanium and silicone, have as little as five parts per million impurities when used for transistors and currently are made by zone refining. Some difficulties such as surface current leaks have been overcome by sealing the transistors in vacuum type canisters or by placing them in ambient atmospheres conducive to good results. The reliability of transistors both mechanically and over periods of time was conclusively demonstrated. In a remarkable demonstration transistors were bounced against a wall, attached to a hammer used to pound a nail in a board, and despite this tremendous vibration they continued to function. The aging quality of the transistors has been greatly improved in the past few years by vacuum sealing.

An array of transistor applications was demonstrated from operating a small microphone to a large computer, from servicing remote telephone relay stations to operating a portable radio. These mighty midgets are not only advancing the technology of communications, but also the sciences of surface physics and ultra pure materials.

Preceding Mr. Ryder's talk, President Kropf paid tribute to the Detroit District and its contributions to the Society. He gave a brief outline of the technical news facing the nation and exhorted the audience to devote their efforts to promoting the professional status of engineers and scientists and to bring young people into the field to fill the need of the country.

NEW YORK

The Science of Engineering Materials

Dr. John H. Hollomon of the General Electric Co., at the New York District meeting, November 19, described the revolution that is taking place with the application of physics and chemistry to the behavior of engineering materials. From the earliest history of the Persians, the Chinese, the Egyptians, to perhaps the middle of the 19th century the properties of the ceramics and the metals then known were controlled and studied largely as matters of chemical composition—the art of the alchemist gradually developing into the science of the chemist. In recent decades, the development and control of the desired materials

properties have been determined also by microstructure, and there is now great promise that properties of future materials enabling us to meet the demands of atomic power, supersonic flight, and space travel may be provided by controlling the arrangements of the atoms within the material.

Dr. Hollomon also told of some of his recent experiences and observations while in Russia last fall for meetings of the International Electrotechnical Commission.

The program was described as "A Night with General Electric" and Clarence H. Linder, vice-president, engineering, in his opening remarks said, "Wherever I go in G. E. today, the problems I find are dependent on engineering materials. . ."

The program was arranged for the district by ASTM Director George H. Harnden of the General Electric Co. About 75 ASTM members and guests attended and took part in the active discussion following Dr. Holloman's talk.

SOUTHEAST

District Council and Officers Elected

The Southeastern District, comprising the states of Florida, Georgia, South Carolina, Alabama, Mississippi, and part of Tennessee, elected its first permanent officers and council under the auspices of the Administrative Committee on District Activities.

The new officers are: Chairman, James A. Lee, Southern Brick & Tile Manufactures Assn.; Vice-Chairman, Robert W. Mooty, Tennessee Coal and Iron Div., U. S. Steel Corp.; Secretary, C. J. McMurry, Rome Cable Corp.; and Assistant Secretary, R. E. Deas, American Cast Iron Pipe Co.

Councillors elected for a term ending in June, 1959 are: W. F. Abercrombie, State Highway Dept. of Georgia; K. W. Dunwody, Cherokee Brick and Tile Co.; J. R. Kattus, Southern Research Institute; R. L. Lock, Anderson Electric Corp., Bryant Mather, Concrete Division, Waterways Experiment Station; Edward C. Miller, Oak Ridge National Laboratory, Union Carbide Nuclear Co.; Horace L. Pratt, Columbia Mills of the Mt. Vernon Mills, Inc.; John C. Sprague, Corps of Engineers, U. S. Dept. of the Army; and A. W. Williams, A. W. Williams Inspection Co.

The remainder of the council whose terms expire in 1960 is comprised of the following: C. J. Blackmon, Atlantic Steel Co.; Earl M. DeNoon, South Florida Test Service; Charles W. Ireland, Vulcan Materials Co.; Blake Lane, West Point Mfg. Co.; A. E. Legg, Penn-Dixie Cement Corp.; James T. MacKenzie, Southern Research Institute; Lane Mitchell, Georgia Institute of Technology; S. N. Pearman, South Carolina State Highway Dept.; Frank E. Richart, Jr., University of Florida; J. Thompson Vann, American Cast Iron Pipe Co.; and P. R. Yoakley, Pittsburgh Testing Laboratory.

President Kropf Speaks at District's First Meeting

The newly formed Southeast District got its activities under way with a bang, providing not one but two get-togethers to greet the President and Executive Secretary.

Through the courtesy of the Bickerstaff Clay Products Co., Columbus, Ga., one of the country's largest manufactures of brick and clay products, a barbecue was held on November 20 followed by an inspection of one of the plants which has a new tunnel kiln which greatly increases production. Then the party proceeded to Shawmut, Ala., to inspect the extensive research facilities of the West Point Manufacturing Co. This was followed by a dinner at one of the company's camps.

Southeastern District Chairman, James Lee, Southern Brick and Tile Mfrs. Assn., presided at both meetings. For the West Point meeting, Blake Lane, in charge of testing, longtime active ASTM committee member, was responsible for all arrangements. Members of the Society were present from a considerable distance including Florida. Following welcomes by West Point vice president Earl Heard who has followed ASTM work for many years, the Executive Secretary spoke briefly and the President presented his textile talk.

OHIO VALLEY

Spirited Discussion on Using Engineers' Talents

President Kropf's district talk "From Cave Man to Space Man via K.O.M." before the Ohio Valley District in Columbus, Ohio, stimulated a spirited question and answer period and some interesting comments on using the talents of engineers and scientists. For example, one college faculty member felt that the channeling of engineers into sales work and related responsibilities was not so desirable, but on the other hand an executive present admitted that in order to get his product introduced and used correctly he had to engage two or three Ph.D's and in other areas of the plant had men with M.A. degrees because the involved new products and processes required training at this level.

Not brought out at this meeting but discussed afterwards was the area of executive and management responsibilities. The trend is definitely today for technically trained personnel to get into management positions. You can hardly stifle this incentive and development. A local committee was headed by J. H. Calbeck, American Zinc Sales Company, Mr. Calbeck being a long time ASTM member and committee member.

Prior to President Kropf's address, Executive Secretary Painter reported on some of the discussions at the recent Rio conference on inter-American Standards. He mentioned the fine spirit of cooperation evident there and told of the intense desire on the part of Latin American engineers present to make progress in organizing national standardizing bodies so that eventually inter-American standards can be considered.

While in Columbus for the Ohio Valley District meeting, President Kropf (center) and Executive-Secretary Painter (left) visited Ceramic Park, headquarters of the American Ceramic Society in Columbus. Between them is District Chairman R. S. Armstrong, Standard Oil Co. of Ohio. Next to President Kropf is C. S. Pearce, secretary of the American Ceramic Society; and on the extreme right, ASTM Director H. C. Cross, Battelle Memorial Inst. The Ceramic Society and ASTM cooperate closely in a number of research and standardization activities, notably in the fields of refractories, ceramic whiteware, porcelain enamel, etc.

At the head table, Ohio Valley District meeting from left to right: Prof. W. R. McIntosh, University of Louisville, Secretary of Ohio Valley District; Professor Chris Geankopolis, Ohio State University; Howard C. Cross, ASTM National Director, Battelle Memorial Institute; Palmer B. Stickney, chairman, Columbus Section, American Chemical Society; ASTM President Richard T. Kropf; R. S. Armstrong, The Standard Oil Co. (Ohio), Chairman of Ohio Valley District; John C. Pitzer, The Formica Co., Past-Chairman of Ohio Valley District; R. E. Christen, Electric Heat Treating Co., Secretary of Columbus Chapter, American Society for Metals; R. J. Painter, Executive Secretary, ASTM; R. R. Litehiser, ASTM National Director, Ohio State Highway Department; and John Calbeck, American Zinc Sales Co., Chairman of Local Arrangements.

During the day, Messrs. Kropf and Painter visited Battelle Memorial Inst. and later visited the relatively new headquarters building of the American Ceramic Society. ACS national secretary, Charles Pearce, attended the ASTM dinner.

A special invitation was extended to those present to attend the ASTM Annual Meeting in Boston the week of June 22 where on Tuesday, June 24, Clyde T. Williams, president of Battelle Memorial Institute, will present the Gillett Memorial Lecture.

The Columbus meeting was held jointly with local chapters of the American Chemical Society and the American Society for Metals.

WASHINGTON

North Carolina State Textile School Host to District

The Washington District was the sponsor of the meetings in Raleigh, but the host was the very active Textile School at North Carolina State College where B. L. Whittier, Chairman of ASTM Textile Committee D-13, is professor. About 100 students and members of the faculty heard two men speak in the afternoon of November 21 and at the evening dinner at the Sir Walter Hotel there were about 60 present to greet the officers. Representing the District officially was C. E. Proudley, chief materials and test engineer, North Carolina State Highway and Public Works Commission, Washington District Vice-Chairman.

During their visit the President and Executive Secretary were able to review a number of ASTM technical and administrative matters with the members and to obtain their opinions on various aspects of the work involving research and standards for materials. It was very apparent that a tremendous amount of research, particularly in the field of textiles, is underway, and this bodes well for the future of this complicated industry.

In his textile talk, President Kropf refers to a wide variety of fibers that are available, both natural and synthetic, and suggests that if the industry could forget or considerably tone down the battle of the fibers and concentrate on expanding uses for textiles as a whole some of the industry's problems might be ameliorated.

DISTRICT FUTURES . . .

New Mexico

A special full-day program will be held on Monday, January 27, 1958, at Albuquerque, N. M., under the auspices of local ASTM members. Two sessions are planned for the program, which will be held at the University of New Mexico. A luncheon and an afternoon coffee break will provide the social events.

Speakers at the meeting will be:

Accelerated Aging Tests and Life Aging Properties of Aircraft Metal Adhesives—*J. P. Thomas, Convair, Division of General Dynamic*

Testing and Exposure Life Test on Metallic Coatings—*C. H. Sample, International Nickel Co.*

Testing for Mold and Fungus Resistance of Materials in Storage—*C. J. Wessel, National Academy of Science*

Concrete and Its Life Qualities—*W. K. Wagner, Albuquerque Gravel Co.*

In addition, Richard T. Kropf, President, and Robert J. Painter, Executive Secretary, will address the group in the afternoon. Two additional speakers will present papers at the afternoon sessions.

This meeting is part of a program designed to determine the feasibility of a formal ASTM organization for this region. H. E. Montgomery, Sandia Corp., is in charge of arrangements for the program to which not only ASTM members and committee men have been invited but also registered engineers in the four states of Utah, Colorado, Arizona, and New Mexico.

Northern and Southern California

In joint meetings at San Francisco and Los Angeles, President Kropf and A. J. Herzig, 1957 Gillett Memorial Lecturer, will be featured speakers. The Southern California District meeting will be held January 23, jointly with the American Society for Metals at the Rodger Young Auditorium.

The Northern California District meeting is planned jointly with The American Society of Mechanical Engineers for Monday, January 30.

Southwest

Senator Antonio J. Bermudez, director of Petrolem Mexicanos and its representative to ASTM, will address a dinner meeting of the Southwest District in Houston, Monday, February 3, 1958. The meeting, jointly sponsored by ASTM Committee D-2 on Petroleum Products and Lubricants and the Southwest District of ASTM, will be held at the Rice Hotel.

President Kropf who will be guest of honor at a Textile Industries Luncheon earlier in the day will also be present for the dinner program. Plans for the day include a textile style show.

1958 Award of Merit Committee

THE 1958 Award of Merit Committee, appointed by the Board of Directors includes H. L. Maxwell and L. C. Beard, serving with holdover members Henry Grinsfelder, Chairman, and F. H. Pennell. R. A. Schatzel will represent the Board of Directors.

In accordance with Rules Governing Award of Merit (see current Year Book) all suggestions for 1958 Awards must be in the hands of the Executive Secretary of the Society for consideration by the Award of Merit Committee not later than Feb. 1, 1958.

Technical Committee Notes

Building Materials Committees Guests of Canadian Research Council in Ottawa

THE BUILDING Research Center of the Division of Building Research, National Research Council of Canada in Ottawa, provided the setting for a group of meetings of ASTM committees in the building materials and construction field the week of October 7. The expanded facilities of the laboratories now provide one of the best equipped centers in North America for the testing of both materials and constructions used in the building industry. The committee members thus had the opportunity of observing the extensive research and testing program being conducted by the National Research Council of Canada.

C-16 on Thermal Insulating Materials

The extent to which the field of thermal insulating materials has grown was one of the first impressions gained at the well attended meeting of Committee C-16 on October 7–10. The committee is now actively engaged in standardization projects on block and pipe, insulation, structural insulating board, blanket and loose fill insulation, reflective insulation, insulating cement, and coatings accessory to thermal insulation. One of the latest forms of insulating material now under consideration is poured-in-place materials. An example of an active project, this one being in the Subcommittee on Block and Pipe Insulation, is a critical review, by means of a questionnaire, of the important physical characteristics in this type of insulation which should be under consideration and therefore test methods and specification requirements developed. Such properties as density, thermal conductance, compressive and flexural strength, pH value, and absorptivity were found to be significant with the majority of these properties already covered in existing standards.

A new development in the committee has been the preparation of recommended practices which are felt to be valuable supplements to the standard specifications. The latest recommended practice accepted for committee letter ballot following review by the Editorial Subcommittee is one on prefabricated and field fabricated insulation coverings for fittings, flanges, and valves.

Of general concern to the entire committee was the importance of securing more complete information to compare laboratory and actual experience data. This need will be stressed in the several subcommittees.

C-20 on Acoustical Materials

The measurement of the sound absorption properties of acoustical materials continues to be the principal activity of Committee C-20, with a fourth draft of the reverberation room test method now under review. Test procedures on a smaller scale are also being developed using the horn coupler with the impedance tube method (C 384) and the latest draft of the box method.

In addition to the basic sound absorption properties, the committee is interested in the flame resistance of acoustical materials, as well as the effect of painting and similar treatment on existing installations of acoustical tile. Several methods of establishing flame resistance classification of acoustical materials have been under consideration, especially a revised form of the test method included in Federal Specification SS-A-118b. There is definite interest also in the tunnel test (E 84) and a series of correlation tests are planned using the five laboratories which are now equipped with the required apparatus.

The committee has been interested for some time in a specification for adhesives for installation of acoustical tile. A Joint Task Group with Committee D-14 on Adhesives developed a proposed specification which was held up because of the need for a suitable aging test procedure. Agreement has been reached on a specification and Committee C-20 is looking to Committee D-14 to present this specification to the Society very shortly for acceptance.

The committee is greatly interested in securing additional consumer representation and extends an invitation to those who might have a direct interest in the use of acoustical materials. Write to the secretary of the committee, J. W. Harrison, U. S. Gypsum Co., 2710 N. Ashland Ave., Chicago 14, Ill.

Methods of Testing Building Constructions

A new project of Committee E-6 which appears to hold considerable interest was initiated by an open conference on the testing of window assemblies. The conference was attended by approximately 50 participants from Canada and the U. S. The initiative has been taken by the aluminum window manufacturers, but the steel and wood window, as well as reinforced plastic, manufacturers, are equally interested. The first activity will be to assemble information on the principal phases of window testing. This information will then be circulated preparatory to the development of actual test methods.

Another new project is the development of a test method for use with vapor barriers beneath concrete slabs-on-ground. Plans were laid for the preparation of a first draft of a proposed method using as a guide existing information prepared by the Forest Products Laboratory. The testing of timber trusses and loading tests for completed structures was also considered. A progress report noted the development of test methods for masonry units. The committee is looking forward to a period of considerable activity both with the new and existing projects on the agenda, all of which should result in standards which will be of real assistance to building officials and others concerned with the actual performance in building structures.

Resistance Materials

Committee Coordinates with Government and ASM Activities

THE American Society for Metals is preparing a new edition of the well-known ASM Metals Handbook, which will include a chapter on electrical heating materials. In view of the simultaneous revision of the ASM Metals Handbook and ASTM specifications along with the periodic issuance of Government specifications covering the same subject matter, a task group

Shown at the Ottawa meetings are some of the officers of several of the building constructions committees. Left to right: R. F. Leggett, chairman of Committee E-6 on Methods of Testing Building Construction; ASTM Associate Executive Secretary R. E. Hess; E. C. Shuman, Assistant Secretary of Committee C-16 on Thermal Insulating Materials; W. C. Lewis, First Vice-Chairman of Committee C-16; J. A. Liska, past-chairman of Committee E-6; H. A. Leedy, Chairman of Committee C-20 on Acoustical Materials; H. J. Sabine, Vice-Chairman of Committee C-20; J. W. Garrison, Secretary of Committee C-20; R. H. Heilman, member of Committee C-16; and W. L. Gantz, Chairman of Committee C-16.

has been appointed to coordinate these activities. Members of the task group include N. E. Spooner, chairman, C. W. Armstrong, Edward Edmunds, and John DeMatteo. Mr. Spooner, a member of the ASM committee will circulate ASM information for study and Mr. DeMatteo, of the New York Naval Shipyard, will get in touch with the appropriate Government officials regarding coordination of ASTM and Government specifications.

Appointment of this coordinating group was one of a number of activities reported at the meeting of Committee B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts on October 17–18 in Pittsburgh. The committee is revising the specification on heating elements of 60 nickel, 16 chromium alloy and is preparing a new specification for 35 nickel, 20 chromium alloy. Wire for wire-wound resistors is the subject of a comprehensive specification in preparation which will cover as many as 12 types of resistor alloys.

The thermostat metals group reported considerable progress toward improving Method B 106 for flexivity testing of thermostat metals to extend the thickness range from a minimum of 15 mils down to 4 mils.

The very active subcommittee on electrical contacts reports that a new machine is being designed to test contact reliability. The need for this is based upon the results of tests in various laboratories which show quite wide spreads between laboratories but close correlation between individual testing procedures.

Electrodeposited Metallic Coatings

Chromated Cadmium and Zinc Exposed at Three Sites

To gather data on the protection afforded by chromate film coatings which have been shown greatly to increase the corrosion resistance of cadmium and zinc plate, Committee B-8 announced at its meeting in Philadelphia that 260 chromated cadmium-plated panels had been exposed at each of three test sites in September: Kure Beach, N. C., Bell Telephone Laboratories, New York, N. Y.; and Rock Island Arsenal, Rock Island, Ill. Reports describing the progress of the atmospheric deterioration will be published in 1959.

Data are now being compiled from a comparative performance test of four commercially produced thickness-measurement gages. Three laboratories collaborated to determine the reproducibility of these devices when used on zinc coatings. A final report will be presented at the next meeting.

In 1955, Committee B-8 broadened its scope to include chemically reduced metallic coatings. Among the new work of this field undertaken by the committee is the preparation of a monograph on electroless nickel. The chairman of the group doing this work is W. E. Moline, National Cash Register Co., Main and K Streets, Dayton 9, Ohio, who will welcome comment on this monograph prior to its publication.

Progress was reported on the collection of data on hardness tests and stress measurement and a series of definitions of terms used in the electroplating industry are being presented for committee comment. The final draft of a monograph on cleaning of metals prior to electroplating is ready for subcommittee action.

Chemical-Resistant Mortars

Development of Testing Procedures Emphasized

The basic property of chemical resistance remains the primary study of Committee C-3. The development of suitable standards for providing testing procedures was emphasized at the fall meeting of the committee, held on October 31 and November 1 at Suffern, N. Y. The Subcommittee on Chemical Properties, under its new chairman, G. P. Gabriel, is being reorganized and expanded to enable more laboratories to participate in a test program which will be approved at the spring meeting. Meanwhile, information on the subject of chemical resistance is being collected, including that from European sources. The effect of compressive strength has been found to be an important factor in the chemical resistance of a mortar.

In the field of silicate-type chemical-resistant mortars, two proposed methods of test were accepted by the committee for letter ballot following review by the Editorial Subcommittee. Working and initial setting time will be included in one proposed method, as the result of round robin tests which have been con-

ducted in three laboratories. A method for the flexural strength of silicate type mortars was accepted with revisions, which include the additional provision of alternate specimens of 2 by 2 by 6-in. size.

Other methods of tests which were reviewed include proposed methods for absorption and apparent porosity for use with silicate, resin and sulfur-type chemical-resistant mortars; and for coefficient of thermal expansion, with or without shrinkage, for which four methods are under consideration.

Refractories

Gas Permeability of Carbon Refractories Moved Toward Standardization

THE RESULTS of an interlaboratory collaborative program to test the validity of a new method of gas permeability of carbon refractories were received by Committee C-8 at its October meeting in Bedford Springs, Pa. A method based on this work will be presented at the next meeting of the committee during ASTM Committee Week.

A survey of the refractories industry on the use of a small scale laboratory test for the spalling of refractory brick has shown that two types predominate: a glow-bar hot plate test in which twelve to sixteen refractory bricks are placed end down on a 1470 F stainless-steel plate, and one in which the ends of the refractory bricks are placed in the open door of a glow-bar furnace. The committee will investigate the value of visual and sonic methods to determine the amount of spalling upon the completion of this test.

Work on the specifications for insulating fire brick in furnaces having negligible atmospheric problems is now complete and will be presented to the committee for action.

Concrete Pipe

Tentative for Concrete Drain Tile Readied

Committee C-13 at its meeting in Chicago, Ill., on October 29, decided that no changes should be made in the specification for Reinforced Concrete Sewer, Storm Drain, and Culvert Pipe C 76 this year, pending additional experience with this new tentative.

A proposed tentative specification for concrete drain tile has been prepared and circulated. The Committee plans to recommend this new draft as a separate concrete drain tile specification from the present drain tile specification (C 4).

A special subcommittee on Rubber Gaskets has been appointed to study the application of rubber gaskets in concrete pipe joints and to prepare a draft of a tentative specification for such joints on rubber composition.

Electrical Insulating Materials

Symposium Shows Growing Use of Statistics in Standards

In setting specification levels, in interpretation of test data, and in the planning and analysis of data in interlaboratory programs, statistics are coming into wider use as an improvement over the old "crystal-ball" methods. Evidence of this increasing interest and emphasis was provided by the symposium on application of statistics, held as an important feature of the meetings of Committee D-9 at Virginia Beach, Va., November 18 to 20. Featured on the symposium were two papers relating to quality control, two relating to mathematical statistics—one on extreme value theory and the other on correlation analysis—and a paper on the use of statistical methods in preparing materials specifications. Symposium chairman was C. J. Photiadis of Westinghouse Electric Co. It is planned to publish the papers and discussion as a *Special Technical Publication*.

Committee activities resulted in final action to ballot on proposed new tentatives, a method for dissipation factor and dielectric constant of polyethylene involving displacement of the material in benzene; a specification for polyester-glass general-purpose laminates; a procedure for testing in the field insulating oil of petroleum origin; and a method for water in insulating oil by the Karl Fischer procedure. Several suggested methods were approved for submission to the Editorial Board of Committee D-9. These included methods for measuring corona resistance of insulating materials, two methods for testing insulating oils, one for oxygen absorption and the other for measuring the tendency of the oil to oxidize. Also approved were methods for thermal stability of varnished fabric employing curved electrodes with one test based on application of proof voltage and the other on dielectric breakdown.

The work on ceramic insulation is being reactivated under the chairmanship of A. H. Scott of the Bureau of Standards. The group agreed to ballot on revisions for all seven of the standards and tentatives under its jurisdiction. This action is timely in view of the widespread interest in ceramic insulation, particularly in the nuclear field and under high-temperature conditions.

The committee is planning to hold two symposia, one in the fall of 1958 on Factors Affecting Dielectric Breakdown, the other in the spring of 1959 on Electrostatic Phenomena.

Glass

Container Tests to Receive Refined Control

RENEWED activity in the refinement of test methods on glass containers was noted at the October meeting of Committee C-14 at Bedford Springs, Pa. It has been found that closer control and instructions are needed in the Method of Polariscopic Examination of Glass Containers (C 148), and to this end a new series of round-robin tests will be run with a report expected at the spring meeting of the committee. A new type of apparatus is being considered in the Method of Internal Pressure Test on Glass Containers (C 147). Close liaison is also being maintained with the U. S. Pharmacopoeia.

Additional information in the form of a new drawing and a complete parts list was accepted as a desired refinement in the Method of Test for Softening Point of Glass (C 338). The desirability of developing a standard method of sieve analysis of raw materials for use in glass making was confirmed at the meeting and a draft outline of a procedure has been distributed for study. There is need for a method of calibrating the sieves and an evaluation of the precision to be expected. Cooperative tests have been planned to develop this type of information.

The committee expressed an interest in cooperating with Committee F-1 on Materials for Electron Tubes and Semiconductor Devices on test methods, but not specifications, for glass used for sealing purposes in electron tubes and other similar devices. An interest was also expressed in the proposed projects on testing window assemblies in Committee E-6 on Methods of Testing Building Constructions.

Structural Sandwich Constructions

Test Method for Impact Resistance Completed

Impact resistance of sandwich core can now be determined by means of a standard method as the result of action taken at the October Meeting of Committee C-19 on Structural Sandwich Constructions held at the

U. S. Forest Products Laboratory, in Madison, Wis. The test for this important property augments a number of other test methods on basic materials which the committee has developed since its organization in 1948.

Standard methods have been published for density (C 271), water absorption (C 272), delamination strength of honeycomb type core materials (C 363), flatwise compressive strength (C 365), and measurement of thickness (C 366). Tentative Method C 365 was recommended for adoption as standard. One of the newest test methods which is being published this year is a procedure for determining the effect of repeated shear loads or fatigue on sandwich core materials (C 394). The need for a method of testing core materials at elevated temperatures is now being investigated. A proposed method for the determination of fluid flow in honeycomb cores is under consideration, with test data to be circulated before acceptance of this method.

At a dinner meeting attended by over fifty members and guests, talks were given by R. F. Blomquist, Forest Products Laboratory, the present Chairman of Committee D-14 on Adhesives, and L. M. Smith, Structures Department of Convair. Mr. Blomquist talked on "What's New in Adhesives," and Mr. Smith discussed the "Use of Sandwich Construction in Convair's B-58." Colored slides of exposure samples at Kure Beach, N. C., and the Pennsylvania State College exposure sites were shown by John Gibbud, Chairman of the Subcommittee on Permanence, Durability, and Simulated Service.

Ceramic Whitewares

Nuclear Applications Subcommittee Will Help Disseminate Declassified Information

PERHAPS no subject in modern times has been approached with keener interest and with a greater stockpile of information largely unavailable heretofore to industry than has the utilization of nuclear energy. Only recently has this information been released to industry for nonmilitary use. Ceramic materials have played a large role in this field and present a great potential for more widespread use. In an effort to assist in the dissemination of this knowledge, Subcommittee V on Nuclear Applications was established at the meeting of Committee C-21 at Bedford Springs, Pa., September 26.

In a round-table discussion, sponsored by this new subcommittee many aspects of the current nuclear information being made available to industry were reviewed. W. W. Galbreath, L. R. McCreight, C. C. Woolsey, and James Crookston reviewed ceramic fuel element considerations, utilization of structural ceramics, literature and radioactive materials available to industry, procedures and clearances necessary for plant utilization of radioactive materials, and current nuclear reactor construction.

The proposed method of test for crazing resistance of fired glazed whitewares by autoclave treatment was presented to the committee. Progress was reported on a method of test for translucency of fired whiteware materials, and recent research on impact resistance apparatus used in the Method of Test for Impact Resistance of Ceramic Tableware (C 368–56) was also presented.

Four new subcommittees have been established: II—Editorial; III—Fundamental Properties; IV—Clay; and V—Nuclear Applications.

Porcelain Enamels

Measurement of Coefficient of Expansion Relates to a Critical Problem

THE COMPOUNDING of porcelain enamel that will have a coefficient of expansion of the same order as the underlying metal is one of the critical problems of the porcelain enamel manufacturer. Five laboratories are now collaborating to study a standard method of measuring coefficient of expansion using one quartz thermometer in order to control accurately the rate of heating which is a critical point in this test.

Further work on the properties of porcelain enamel materials reported at the October meeting of Committee C-22 in Chicago includes methods to determine the consistency of enamel slip and a standard reboil test. In the reboil test, the severity of reboiling damage exhibited by the specimen could be denoted by selecting a number, with the help of reference charts, the cube of which would be the number of blisters per square inch. This method of rating reboiling severity would retain the simplicity of visual ratings now used with the addition of a quantitative means of rating. A great many factors and variables are being considered in setting up a systematic experiment for this test. The project chairman, H. S. Saunders, O. Hummel Co., Box 475, Pittsburgh 30, Pa., would like to receive any comments concerning this program.

Fishscaling is an enamel defect that appears as small half-moon shaped structures somewhat resembling fish scales. One of the suspected causes of fishscaling is the release of hydrogen gas absorbed in the base metal. Various new methods of measuring the amount of hydrogen gas absorbed in the enameling iron were reviewed at the meeting. It is expected that these new methods will soon provide data which will assist in solving this difficult problem.

Shipping Containers

Revisions in Water Vapor Permeability Methods Completed

THREE interlaboratory test studies have shown that revisions are being completed in the water vapor permeability methods D 1008, D 1251, and D 1276, it was revealed at the meeting of Committee D-10 on October 30, 31 in Atlantic City, N. J.

A new task group to study the reproducibility of the incline impact test met to define its program of work. Although this Standard Method D 880 has stood for many years, each laboratory has many interesting variations of testing packages on this machine. This poses a problem of standard procedures that will be studied by the new task group.

The work on interior packing continues to accelerate. The third interlaboratory program of dynamic testing of ten cushioning materials having known characteristics, utilized pendulum and drop-type machines for the accelerometer tests. These tests, summarized at the meeting, represent a tremendous amount of work and will form the basis of a procedure for dynamic testing of cushioning materials now in preparation.

Task Groups on dusting and breakdown and compatibility presented proposed methods on these subjects for review and comment.

Adhesives

Standards Work in Metal Bonding and Wood Adhesives Inaugurated

THE organization of two new subcommittees at the November meeting of Committee D-14 in Philadelphia marked the beginning of specification development in the fields of (1) metal bonding, and (2) wood adhesives. The metal bonding group is of great importance now to the aircraft field as well as in the future in the automotive and building construction fields. The work, as outlined at the meeting, will be handled by sections on mechanical properties, durability, metal service preparation, and inspection and quality control methods. Organizations interested in contributing to the standardization work of the subcommittee on structural metal-bonding adhesives are urged to get in touch with Mrs. H. R. Merriman, The Martin Co., Baltimore, Md.

The new subcommittee on wood at its first meeting reviewed problems of recognition and classification of the products and properties of wood adhesives that should be covered. Work in this area, has been delayed to some degree because of the great diversity in requirements for such adhesives and the lack of suitable means for classifying these to permit a properly focused attack. The broad scope of this new subcommittee will permit a simultaneous approach to all of these problems. Since an adhesive consumer has in mind primarily the idea of purchasing an adhesive which will give satisfactory performance for the particular constructions utilizing his product, the first work will be on performance standards. Performance is composed of two distinct elements—durability, and working properties or useful characteristics. To be meaningful, a standard specification should provide assurance that the complete anticipated performance of the adhesive purchased under this specification will be met.

The subcommittee reviewed three distinct areas of performance characteristics: the construction for which the adhesive is to be used, the durability requirements based on exposure, and working properties anticipated by the manner in which the adhesive is to be used.

A proposed recommended practice for sampling adhesives was presented at the meeting for committee attention and comment.

Other standards in process are: specifications of adhesives for acoustical tile, a method to determine the nonvolatile content of phenol, resorcinol, and melamine adhesives, and the determination of nonvolatile content of solvent-type resin adhesives.

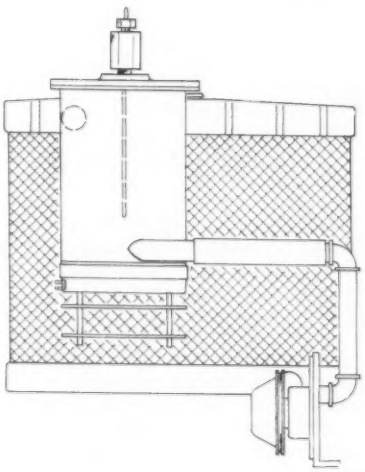
Engine Antifreezes

Corrosion Studies Aided by New Test

THE PROBLEM of corrosiveness of engine antifreezes has been one of long standing in the automotive industry. Committee D-15, along with many other agencies, has published much information to discourage the use of mineral salts as a freezing point depressant for coolants. The largest volume of engine antifreezes presently uses methanol and ethylene glycol. These materials will also cause corrosion to some extent and inhibitors must be added for improved protection. Water used as a diluent for antifreezes varies in composition throughout the United States and variations in the engines themselves all play a role in the corrosion problem.

The committee has, for the past several years, conducted collaborative test programs to produce a satisfactory corrosion test for antifreezes. The three-phase program includes: a glassware screen test, a bench test capable of equivalent service simulation, and a road test. In 1955, the committee published the first phase of the test program by issuing the Tentative Method for Glassware Corrosion Test for Engine Antifreezes (D 1384). In this method, six metal specimens are placed in an antifreeze diluted with distilled water and circulated by aeration.

At the meeting of Committee D-15 on November 15, the completed apparatus for the second phase, the mechanical bench equipment test, was announced.



A reservoir (see above) equivalent in size and material to an engine block reservoir has been designed so that three sets of metal test specimens may be mounted inside. The lid can be opened for sandblast cleaning, permitting reuse. For the first interlaboratory test program of this equipment, about twenty units are being fabricated. Information concerning the purchase of this reservoir and the procedures to be used for this program may be had from V. O. Hatch, Paint and Chemical Laboratory, Aberdeen Proving Ground, Md.

Plastics

Five Plastic Pipe Specifications Among Eleven New Tentatives

Nearly 200 people attended the meetings of Committee D-20, held at Virginia Beach, November 20–22. Judging from the number of new methods and specifications approved for ballot in the committee, a good account was made of the time spent there. Approved for ballot were eleven new tentatives including five relating to plastic pipe: Dimensions for acrylonitrile-butadiene-styrene (ABS) pipe; specifications for solvent welded pipe and polyethylene pipe; and two burst test methods, one for short-time and the other for long-time tests. Also included in the list are tests for Vicat softening point of plastics, method for dilute solution viscosity of polyethylene, and method for bearing load of reinforced plastics panels. Specifications approved for ballot covered biaxially oriented polystyrene sheet, nonrigid poly(vinyl chloride) film, and random chopped glass fibers and mat for use as a reinforcement in plastics.

Of particular interest to those concerned with the use of plastics in buildings was the report of progress on the radiant panel fire test. Work on this method has progressed to the point where it is to be recommended to ASTM Committee E-5 on Fire Tests of Materials and Construction for consideration and recommendation as a tentative method.

As a result of a recent questionnaire on new fields of work, a number of new projects have been turned over to subcommittees for initiation. These cover tests for coefficient of friction, flexibility of film, dart and ball impact tests, fungus resistance, color, staining, and several others. Also included in the results of the questionnaire was a definite evidence of interest in sampling and interlaboratory test procedures. So that these interests may be taken in hand and work initiated, the chairman of the committee was authorized to establish a new subcommittee covering statistical matters and, in particular, sampling plans and interlaboratory testing.

A special feature of the meeting was an evening research session. Four papers were presented covering fiberglas flake reinforcement, statistical methodology for environmental stress-cracking data, new rheometer for thermoplastics, and behavior of poly(methyl methacrylate) plastics under uniform load. A. C. Webber, vice-chairman of the committee, presided.

Electron Tubes

Interface Imp Won't Cooperate

INTERFACE IMPEDANCE—that performance-robbing imp in a vacuum tube—just won't cooperate. It persists in having a value just outside the accurate range of most of the instruments for measuring it in a great many tubes. This information was part of a report of an extensive analysis by the

Bell Telephone Laboratories of interlaboratory data on interface impedance measurements. The report was presented at the meeting of Committee F-1 on Materials for Electron Tubes and Semiconductor Devices, held at Skytop, Pa., in November. Analysis of data from these tests which had been collected on punch cards revealed the ability of the industry to make interface impedance measurements. It was found that within the normal sensitivity of the instruments used, as described in ASTM Methods F 300, the reproducibility was good. However, outside this range and particularly when measuring very low values of impedance, reproducibility was poor. Quite a few of the tubes measured fell in the range of poor sensitivity of the instruments. The results indicate the direction the committee's efforts should take in improving the method for interface impedance measurements.

Another elusive problem in the electron tube part involves the adherence of the oxide coating on nickel-cathode sleeves. One of the difficulties in determining the cause of poor adhesion is that there is no known method for measuring the adhesion of the coating. A group on the committee has drafted a statement of the problem for publication in the Society's collection of problems in "Challenges in Materials Research." It is hoped by this means to interest companies and individuals not represented on the committee in making some contribution toward its solution.

The subcommittee on metallic-nonmetallic seals had a very active session. Sections have been organized on metallic and nonmetallic materials for seals, metal sealing wires, and standard seals. A good deal of effort has been toward developing a test for thickness of the oxide coating on lead wires. A report by E. C. Slick of Sylvania, indicated that a reproducible method had been devised involving the comparison of the color of the oxide coating on the wire with that of color standards. The group concerned with standard seals is developing standard ceramic to metal seals and standard glass to metal seals. Effort is toward development of two standard test specimens—one for tension tests and the other for tension, compressive, and shear tests.

Work on luminescent materials is progressing to the point where the committee is about ready to suggest a procedure for measuring wet strength of phosphor screens. Work is progressing also on development of a method for dry strength.

The subcommittee on strip is currently concerned with methods for carbon adherence, gas content, and thermal emissivity.

Some of the problems confronting the wire subcommittee are concerned with the measurement of hot resistance of wire and specification of lead wires for miniature tubes. Bearing on those problems are those having to do with the use of series string heaters and associated problems of control of heater current.

The insulator group has completed work in the development of a specification for aluminum oxide powder and is prepared to recommend it for publication as tentative.

Leather

Maeser Test Gets Go Ahead

How DOES one measure the effect of water on leather? While the average person does not deliberately wade in puddles to see if his shoes are waterproof, wet feet may be a very practical concern for the sportsman, the outdoor worker, and the soldier. The problem of how to measure the penetration of water through leather was one of several that held the attention of the Joint ALCA-ASTM Committee on Leather at its meeting on October 17 and 18, at the Netherland-Hilton Hotel in Cincinnati.

An extensive interlaboratory test was reported, involving the evaluation of nine different types of upper leather by eleven laboratories and using seven different test methods for measuring water penetration. While, as might be expected, there was considerable spread in the results, one method—a dynamic flexing test developed by M. Maeser, United Shoe Machinery Co., and in use for sometime—was selected for further consideration. This method is to be drafted and circulated for ballot.

Surface characteristics of leather have an important bearing on its appearance and utility in such applications as upholstery and clothing. The committee has investigated a method for determining crocking and will draft it for ballot. Other methods bearing on surface characteristics being investigated are for measurement of tendency of a finish to crack upon flexing, resistance to scuffing, and light fastness. Plans are under way for an extensive investigation of methods for evaluating light fastness. The test program will involve nine different types of leather with three colors for each type, and the test program will include several laboratory light sources, some involving only light and others adding the effects of water and humidity. Results of these tests from three different laboratories will be compared with those from specimens exposed outdoors at the General Motors exposure test facility in southern Florida.

The committee also has a very active and full program for the establishment of standard procedures for sampling and conditioning, and for various mechanical tests including tension, tongue tear, stitch tear, etc.

Much of the discussion both in the meetings and in the hotel corridors, was in attempting to answer the questions: "what do these tests mean?—what is their significance?—how can they be applied?—how are the results to be interpreted?" The committee is keenly aware of the importance of significance and applicability of tests and it was established as a policy that all methods to be recommended as tentative would be studied carefully from this point of view so that the users of the tests might be guided in interpreting the results obtained.

Nuclear Engineering and Science Conference

ASTM is one of more than thirty engineering and scientific societies sponsoring the Fourth Nuclear Engineering and Science Conference to be held at the Chicago International Amphitheatre in March. It is expected that approximately 200 papers will be presented at 25 technical sessions.

The National Industrial Conference Board and the Atomic Industrial Forum, Inc., will jointly sponsor an Atomic Energy Management Conference which will be part of the Congress. The conference is designed to provide management with a comprehensive review of the progress that is being made throughout the world in the development of low-cost nuclear power and other industrial uses of atomic energy.

The Atomic Industrial Forum, Inc., "Atomfair," will be held in conjunction with the technical sessions of the Congress and will feature the latest developments in industrial uses of atomic energy. Registration for Atomfair is open to Congress delegates and to science-minded people in industry.

Preprints of papers will be available in advance at a nominal cost. They may be ordered from the order form distributed in January with the Advance Program.

Copies of the Advance Program may be obtained from the secretaries of the participating societies or from the secretary of the Engineers' Joint Council, 29 W. 39th St., New York 18, N. Y.

SERIES 2

New SBR Numbers

Assignments by Committee D-11 on Rubber

COMMITTEE D-11 on Rubber and Rubber-like Materials has assigned numbers to two styrene-butadiene rubbers, namely SBR 1061 and SBR 1551. While these two SBR numbers have been in use for some time, they have now been assigned and made part of the system of code numbers for synthetic elastomers. The assignment of these numbers is in accordance with the practice established by Subcommittee XIII on Synthetic Elastomers of Committee D-11, and agreed to earlier this year by the committee, the Society, and private producers of SBR and SBR latices. The code numbers previously assigned to five styrene-butadiene rubbers (SBR) and three SBR latices were covered in the ASTM BULLETIN, September, 1957, page 18.

These two new SBR numbers are included in the letter ballot now under way in Committee D-11, in order to bring up to date the Tentative Recommended Practice for Description of Types of Styrene Rubbers (D 1419 – 56 T).

The two new SBR numbers and the corresponding product descriptions are shown in Table I.

TABLE I.—ASSIGNMENT OF NEW CODE NUMBERS—ASTM D 1419 – 56 T DESCRIPTION OF TYPES OF STYRENE-BUTADIENE RUBBERS (SBR).

Number Assigned	SBR 1061	SBR 1551
Date assigned	9/5/57	9/5/57
Requested by	Texas-U. S. Chemical Co.	Texas-U. S. Chemical Co.
Distinctive feature	NST SBR 1000 Type	NST SBR 1500 Type
Close previous number, if any	1061	1551
Type	NST hot unpigmented	NST cold unpigmented
Nominal temp, deg. Fahr.	122	43
Activator	—	FRA
Shortstop	ND	ND
Antioxidant	NST	NST
Catalyst	P	OHP
Emulsifier	FA	RA
Nominal bound styrene, per cent	23.5	23.5
Conversion, per cent	68	60
Mooney viscosity, ML, 1 + 4, 212 F., polymer	50	52
Coagulation	SA	SA
Finishing	Normal	Normal

Note: Abbreviations and symbols are defined as follows: FA = fatty acid. FRA = free radical type, that is iron-pyrophosphate peroxamine sulfoxylate. ND = nondiscoloring. NST = nonstaining. OHP = organic hydroperoxide. P = persulfate. RA = rosin acid. SA = salt-acid.

College-Industry Conference

NEW Concepts in the Education and Development of Technical Manpower is the theme of the 1958 College-Industry Conference of the American Society for Engineering Education to be held at the University of Michigan, January 30 and 31.

Four speakers will present the new concepts arising from current research: Paul Reinert, president of St. Louis University, will speak on "New Concepts in Education from the President's Committee on Education Beyond High School"; Andrew A. Kucher, vice-president of engineering and research, Ford Motor Co., will have "New Concepts in Engineering" as his topic; Donald C. Pelz, University of Michigan Survey Research Center, "New Concepts Useful in Motivating Engineering and Technical Personnel"; Ilee Danielson or John W. Riegel, University of Michigan Bureau of Industrial Relations, "New Management Concepts Obtained Through Interviews with Employed Engineers and Technicians."

Four additional speakers will describe new programs designed by their companies to utilize new concepts of professional development—W. R. Collings, president of Dow-Corning Corp.; E. E. Sivacek, chief engineer, King-Seeley Corp.; A. L. Bain, superintendent of engineering training for Western Electric Co.; L. V. French, director of engineering personnel for Whirlpool-Seeger Corp.

Additional information can be obtained from the University of Michigan, College of Engineering, 255 West Engineering Building, Ann Arbor, Mich.

OTHER SOCIETIES' EVENTS

December 26–31—**American Assn. for the Advancement of Science,** 12th Annual Meeting, Claypool Hotel, Indianapolis, Ind.

January 6–8—**4th National Symposium on Reliability and Quality Control in Electronics,** Statler Hotel, Washington, D. C.

January 9–10—**American Society for Engineering Education,** Education Div., Midwinter Meeting, Dallas, Tex.

January 13–17—**Society of Automotive Engineers,** Annual Meeting and Engineering Display, Sheraton-Cadillac and Statler Hotels, Detroit, Mich.

January 20–23—**American Road Builders Assn.,** Annual Convention and Highway Materials and Services Exhibit, Sheraton-Park Hotel, Washington, D. C.

January 20–24—**American Institute of Electrical Engineers,** Winter Meeting, Hotel Statler, New York, N. Y.

January 27–29—**American Society of Heating and Air-Conditioning Engineers,** 64th Annual Meeting, Penn Sheraton Hotel, Pittsburgh, Pa.

January 27–31—**Institute of the Aeronautical Sciences,** Annual Meeting, Hotel Sheraton-Astor, New York, N. Y.

January 27–31—**American Institute of Electrical Engineers,** Committee on Technical Operations, New York, N. Y.

January 28—**Mining and Metallurgical Society of America,** Annual Meeting, New York, N. Y.

January 28–29—**Radio, Electronics and Television Mfgs. Assn.,** Conference on Automation, Arizona State College Phoenix, Ariz.

January 28–31—**Society of Plastics Engineers,** 14th Annual Technical Conference, Sheraton-Cadillac Hotel, Detroit, Mich.

January 29–30—**American Welding Society,** Chicago Section, and **Armour Research Foundation,** Midwest Welding Conference, Illinois Institute of Technology, Chicago, Ill.

January 30–31—**American Society for Engineering Education,** College-Industry Conference of the Relations with Industry Div., University of Michigan, Ann Arbor, Mich.

February 4–6—**Society of the Plastics Industry,** Reinforced Plastics Div., Edgewater Beach Hotel, Chicago, Ill.

February 10–13—**National Sand and Gravel Assn.** and National Ready Mixed Concrete Assn., Joint Convention, Conrad Hilton Hotel and Coliseum, Chicago, Ill.

February 16–20—**American Inst. of Mining, Metallurgical and Petroleum Engineers,** Annual Meeting, Hotel Statler, New York, N. Y.

February 24–26—**National Concrete Products Assn.,** 9th Annual Convention, Seigniory Club, Montebello, Quebec.

February 24–26—**National Concrete Contractors Assn.,** 1st Annual Convention, and Concrete Exposition, Coliseum, Chicago, Ill.

February 24–28—**American Society of Civil Engineers,** National Convention, Sherman Hotel, Chicago, Ill.

February 25–27—**American Concrete Institute,** 54th Annual Convention, Morrison Hotel, Chicago, Ill.

Standards Engineers' Honors

THE HIGHEST award of the Standards Engineers Society—Honorary Life Fellowship—was bestowed in September upon Howard Coonley, vice-chairman of the board, Research-Cottrell, Inc., New York.

At the Sixth Annual Meeting Awards Luncheon Fellowships were awarded to three SES members: Cyril Ainsworth, W. L. Healy, and George Noble.

What Can Be Done to Improve Alloy Phase Nomenclature?

A Report of Nomenclature Subcommittee[1] of Committee E-4 on Metallography

During the past few years, Subcommittee III of ASTM Committee E-4 on Metallography has been engaged in developing an improved nomenclature for metallic phases. A number of experts in various countries also contributed ideas and constructive criticism during the years of preparatory work. The subcommittee has tentatively arrived at a possible scheme for systematic phase nomenclature which appears in the accompanying article. It is being submitted to the leading metallurgical societies throughout the world with an invitation for them to submit critical comments, or to suggest alternative systems. It is hoped that the various national institutions will collaborate to the full in making this scheme known to their members and in making suggestions regarding the eventual adoption of a unified system of nomenclature.

In current metallurgical literature, the phases occurring in binary and more complex alloy systems are usually named by Greek letters (for example, α-iron, β-brass, etc.), by Latin capital letters (for example ternary phases, such as S and Z in the aluminum copper-magnesium system), or by chemical formulae (for example $CuZn_2$, CdSb, Mg_2Sn, etc.). These three types of phase designation overlap, so that a phase referred to by some authors as Cu_5Zn_8 is commonly designated also as γ-brass. At present, phase nomenclature is not systematic and not unique.

The assignment of Greek letters to various phases has been rather arbitrary. Isomorphous phases in different binary systems have frequently been given different names. For instance, the sigma phase in the iron-chromium system and the gamma phase in the cobalt-chromium system are isomorphous; as in many other similar cases, the implied difficulty became evident when it was found that in the iron-cobalt-chromium ternary system the two isomorphous binary phases are connected by a continuous ternary solid solution field. In such situations, where the two ends of a continuous solid solution field bear different names, the present confusion in phase nomenclature is clearly brought to light. Undoubtedly, a systematic phase nomenclature should be free from such self-contradictions. The problem is becoming of increasing practical importance as the group of investigated ternary and more complex phase diagrams is rapidly growing.

The difficulty in avoiding such contradictions lies in the fact that at the time names are assigned to the phases occurring in binary systems, the corresponding ternary and more complex systems are usually not well known. If this were not so, and one could start for instance with a single $n+1$ dimensional phase diagram ($n-1$ composition variables, temperature, and pressure) for the n elements to be considered, it would be easy to eliminate contradictions. All one would have to do is to assign a name to each phase that is identified by a continuous field in this $n+1$ dimensional phase diagram and that is separated from other phases by 2-phase of multiple-phase fields. Phase diagrams of lower complexity may be considered as sections through the $n+1$ dimensional phase diagram. If all sectional single phase fields derived from a certain $n+1$ dimensional phase field would be given the same name when they occur in the separate sectional systems, obviously no contradictions could arise when the phase diagrams of lower complexity are combined into more complex diagrams. However, since actual knowledge progresses from simpler toward more complex systems, it is desirable to find a more practicable basis for a systematic and unique phase nomenclature.

Basis for a Rational Phase Nomenclature

It appears that the most likely basis upon which a self-consistent systematic nomenclature might be built is the crystal structure. Although it is possible in some cases for a continuous solid-solution field to connect crystal structures that differ in certain respects, (and it is, furthermore, by no means certain that all phases with the same crystal structure, which occur in sectional phase diagrams, will combine into a single phase field in the $n+1$ dimensional diagram mentioned above) the use of the crystal structure appears to be the best available basis for a self-consistent phase nomenclature. The outline of a system of nomenclature based on this expectation is described below.

The basic requirements for a rational phase nomenclature may be summarized as follows: a single system of nomenclature should be applicable to all metallic phases. Each phase should have only one name, uniquely identifying it. The system should assure freedom from contradiction when phase diagrams of lower complexity are combined into more complex ones. In addition to these basic requirements, there is an important practical one: the symbols used for phase designation should be as simple as possible. This requirement prevents the use of phase designations for the purpose of conveying additional information that is not necessary for the unique identification of a phase. In

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] K. W. Andrews, United Steel Companies, Ltd., England; R. S. Busk, The Dow Chemical Co., U.S.A.; W. L. Fink, Aluminum Company of America, U.S.A.; Max Hansen, Metallgesellschaft, Frankfurt a.M. Germany; W. Hume-Rothery, University of Oxford, England; F. Laves, Polytechnic Institute, Zurich, Switzerland; T. Lyman, American Society for Metals, U.S.A.; J. S. Marsh, Bethlehem Steel Co., U.S.A.; G. V. Raynor, University of Birmingham, England; F. N. Rhines, Carnegie Institute of Technology, U.S.A.; C. S. Smith, University of Chicago, U.S.A.; A. J. C. Wilson, University College, Wales (U. K.); P. A. Beck, University of Illinois, U.S.A.; *chairman*.

order to carry additional information, the phase designation would have to be made more elaborate, which is undesirable.

Tentative Outline of a Possible Phase Nomenclature for Metallic Systems

The suggested symbol to be used for designating a phase would consist of two parts. The first part is a list of the chemical symbols of the elements occurring in the phase in significant quantities; these chemical symbols are listed in order of decreasing atomic percentage, and are placed in round brackets (parentheses). The second part of the phase designation describes the crystal structure of the phase.

The chemical symbols of the elements, listed in the first part, are separated by commas, for example: (Cu,Zn)2*C* where 2*C* is an example of the crystal structure symbols discussed later in detail. Although this arrangement is generally applicable, it is particularly appropriate for typical metallic phases, such as electron compounds and phases with wide ranges of composition. When it is desirable to emphasize that the phase consists of an uninterrupted series of solid solutions between the components, the chemical symbols of the elements may be separated by hyphens, for example: (Cu-Ni)4*F*. When it is desired to suggest that the phase may be essentially ionic or covalent in nature, or to emphasize that the use of a chemical formula is justified by the crystal structure, as in Laves phases and other "atomic-size compounds," the listing of the components may be replaced by a suitable chemical formula, such as (Fe_3C) or ($MgCu_2$). Since the alternative use of chemical symbols, separated by commas, and of chemical formulae would not endanger unique identification of the phase, the choice may be left in some measure to the preference of the individual user. However, it should be pointed out that in some cases where chemical formulae had been used in the past, the same phase was afterwards found to occur in analogous systems at varying atomic ratios. A case in point is the occurrence of the sigma phase at compositions approximately corresponding to all of the following formulae: VMn_4, VFe, V_3Ni_2. Other examples are provided by the electron compounds. In such cases, which may mean the majority of typically metallic phases, the justification of the chemical formula on the basis of crystal structure or fundamental significance may be subject to question.

Whenever a phase designation is used in conjunction with a specific phase diagram on which the components are already indicated, the first part of the symbol may be omitted altogether. The use of the complete symbol here may not only be unnecessary, but also too cumbersome and space consuming. Thus, for example, in referring to the face-centered cubic solid solution phase in the copper-zinc system, it is sufficient to use the crystal structure symbol, since it completely specifies the phase referred to. An exception should be made when a system has two separate phases of the same structure, which can be distinguished from each other by listing the components in the proper order, for example: (Cu,Ag)4*F* and (Ag,Cu)4*F* designate the two face centered cubic terminal solid solutions in the copper-silver system. Another case where the first part of the symbol used for phase designation can be omitted is where reference is made to common properties of structurally related phases, regardless of the specific chemical composition. This provision conforms to general practice in speaking of the crystal structure, or the brittleness of the sigma phase, for instance.

The second part of the symbol designating a phase should identify the crystal structure. Features desirable in a crystal structure symbol for phase designation are easy pronunciation, easy typing and printing, and adaptability to punched card techniques. These considerations would favor the use of the Latin alphabet (either capital or lower case) and of arabic numerals, without subscripts or superscripts. The system that had been used in the Strukturbericht[2] satisfies these conditions, and it is also quite widely known. Despite these advantages, for reasons outlined in the Appendix, it was felt that the scheme of structure designation to be described in the following would be more satisfactory.

The suggested structure designation incorporates a capital letter (printed in italics, or typed underlined) specifying one of the 14 Bravais lattices. For ease in memorizing, the primitive lattices were designated, as far as possible, with a capital letter corresponding to the initial of the crystal system concerned (for instance: *C* for primitive cubic, *T* for primitive tetragonal, etc.). Subsequent capital letters of the alphabet were then used as much as possible to designate the corresponding body-centered, base-centered, and face-centered Bravais lattices, in this order. Exceptions were allowed, for instance in the case of cubic lattices, again for mnemonic reasons (*B* for body centered cubic and *F* for face centered cubic). The list of Bravais lattices, with the designation suggested for each, is given in Table I:

TABLE I.—BRAVAIS LATTICES.

C primitive cubic	*O* primitive orthorhombic
B body centered cubic	*P* body centered orthorhombic
F face centered cubic	*Q* base centered orthorhombic
T primitive tetragonal	*S* face centered orthorhombic
U centered tetragonal	*M* primitive monoclinic
R rhombohedral	*N* centered monoclinic
H hexagonal	*Z* triclinic

Another feature of the structure designation considered is a number giving the number of atoms per unit cell. This number precedes the symbol designating the Bravais lattice to avoid possible confusion with Strukturbericht designations. Since, in many cases, there is more than one structure known with the same Bravais lattice and the same number of atoms per unit cell, in such cases an additional lower case letter is inserted between the number and the capital letter, so that different structures may be distinguished from each other. Table II lists metallic structures, each identified by a typical representative, together with the suggested structure designations. Many of the more complex structures listed here for the sake of reasonable completeness will probably be of infrequent practical use to metallurgical engineers.

It may be pointed out that the lower case letter (for example a in 30*T*a) could be omitted for many purposes, without loss of clarity. Conversely, such a letter could be included where not at present used, if the desirability of such change is indicated by subsequent work.

A simple extension of the suggested scheme could be adopted by users who wished to give more complete information regarding a crystal structure, by substituting for the number of atoms per unit cell the numbers of crystallographically equivalent atoms in various lattice positions (for example the symbol for β-Mn structure may be expanded from 20*C* to 8,12*C*). It is recognized, however, that the structure designations for the phases most commonly referred to in practice by metallurgical engineers would remain very simple two-digit symbols, such as 4*F*, 2*B*, and 2*H*—a very desirable practical feature.

In the relatively few instances where the crystal structure changes gradually from one to another within a single solid-solution field, the Bravais lattice is usually of the same type for both structures, and only the number of atoms per unit cell changes gradually. Examples of this kind:

[2] P. P. Ewald, *et al*, Strukturbericht, Akademische Verlagsgesellschaft, Leipzig, 1913 to 1939.

1. Interstitial solid solutions based on a face centered cubic structure (4*F*), in which the octahedral holes are progressively filled up by interstitial atoms until finally an NaCl-type structure (8*F*) is attained. The solid solution of carbon in austenite is of this general type, although it terminates long before reaching the full NaCl-structure.

2. Holes in an NiAs-type structure (4*H*) may be filled up until finally an Ni_2In-type structure (6*H*) is reached.

3. A CaF_2-type structure (12*F*) may take up interstitial atoms into solid solution until finally a BiF_3-type structure (16*F*) is reached.

In all such cases the structure symbol may express the variable number of atoms per unit cell. For the first example listed, the symbol 4–8*F*, for the second, 4–6*H*, for the third, 12–16*F* may be used. Where the change is only partial, as in austenite, a symbol such as 4+x*F* is suitable to show that the number of atoms increases from 4 to a higher, temperature-dependent value.

If further research should uncover some instances of continuous solid solutions with gradually changing Bravais lattice, these could be similarly designated by symbols, such as *C-T* (for a continuous solid solution field between a cubic and a tetragonal structure).

In phase diagrams in which two distinct phases of the same structure occur, these phases may be distinguished from each other by affixing after the capital letter (italics) designating the Bravais lattice a lower case (roman) letter (for example a, b, c, etc.). Thus, in the aluminum-zinc system (Fig. 2) up to the critical temperature the two coexisting face centered-cubic phases may be designated as 4*F*a and 4*F*b. Above the critical temperature the single face centered-cubic phase would be designated simply as 4*F*. In some instances it may be desirable to aid further in this kind of differentiation by changing the sequence of the chemical symbols in the bracket in the first part of the phase designation, to correspond with the different compositions of the two phases of identical structure. This device, which was discussed previously, appears to be particularly useful when the two phases of the same crystal structure are terminal phases, so that their compositions are decisively different from each other. Both kinds of differentiation might be used together, if desired. For example, in the copper-silver system the copper-rich solid solution might be designated as (Cu,Ag)4*F*a, and the silver-rich solid solution as (Ag, Cu)4*F*b. In the ternary copper-silver-gold system (Fig. 3), similar designations could be used in the composition range where two face-centered cubic phases co-exist; the simpler designation (Cu,Ag,Au)4*F* would be sufficient when referring to solid solution alloys in the single-phase field. If the designation is used in conjunction with a phase diagram which shows the chemical symbols of the components, it is unnecessary to use chemical symbols in the phase designations (see Figs. 1, 2, and 3). In some phase diagrams even the structure symbols by themselves would be too bulky for easy inclusion in the appropriate phase fields. In such cases simple one-letter symbols (for example lower case italics) may be used, together with an adjoining legend or table relating the symbols used in the diagram to those corresponding to the structure, as described before.

Phases with unknown crystal structures might be designated by Greek letters. For example: (Mo,Ni)δ. To each Greek letter there corresponds a characteristic X-ray diffraction pattern, as yet unindexed, so that phases in different alloy systems having the same (unknown) crystal structure would be assigned the same Greek letter. When

TABLE II.—DESIGNATION OF METALLIC STRUCTURES.

Structure Represented by	New Symbol	Structure Represented by	New Symbol	Structure Represented by	New Symbol
Cu	4*F*	CdI_2	3*H*b	Mn_2O_3	80*B*
W	2*B*	MoS_2	6*H*d	Sb_2S_3	20*O*a
Mg	2*H*a	CaC_2	6*U*a	Zn_3P_2	40*T*
Diamond	8*F*a	$MoSi_2$	6*U*b	Cr_3C_2	20*O*b
Sn	4*U*	$CaSi_2$	6*R*b	Ni_2Al_3	5*H*b
In	2*U*a	$MgZn_2$	12*H*b	U_3Si_2	10*T*b
As	2*R*a	$MgCu_2$	24*F*	Pt_3Sn_2	10*H*
Se	3*H*a	$CuAl_2$	12*U*a	Pu_2C_3	40*B*a
Graphite (α)	4*H*a	FeS_2 (Marc.)	6*O*	Ni_3S_2	5*R*b
Graphite (β)	2*R*b	Fe_2P	9*H*b	As_2S_3	20*M*
Hg	1*R*a	$PbCl_2$	12*O*a	Al_4C_3	7*R*a
Ga	8*S*a	AlB_2	3*H*c	Co_9S_8	56*F*a
Mn (α)	58*B*	Bi_2Te_2S	5*R*a	Th_3P_4	28*B*
Mn (β)	20*C*	$AuTe_2$ (Cal.)	6*N*	Ni_3Sn_4	14*N*
Cr_3O	8*C*a	$MgNi_2$	24*H*a	Ta_3B_4	14*P*
S	128*Q*	Co_2Si	12b*O*		
U (α)	4*S*a	Cu_2Sb	6*T*	Fe_3Zn_{10}	52*B*a
Pa	2*U*b	$CrSi_2$	9*H*c	Cu_5Zn_8	52*B*b
U (β)	30*T*a	SiS_2	12*P*	Cu_9Al_4	52*C*
Np (α)	8*O*a	GeS_2	72*Q*	$Cr_{23}C_6$	116*F*a
Np (β)	4*T*a	AuTe$_2$ (Krenn.)	24*O*a	Fe_7W_6	13*R*
$TiCu_3$ (β)	4bs	$ZrSi_2$	12*S*	$Cu_{31}Si_4$	76*B*
$HgSn_{10}$	1*H*	$TiSi_2$	24*Q*	Mn_5Si_3	16*H*b
B	50*T*			Co_9S_8	68*F*
Po (α)	1*C*	Mg_2Ni	18*H*a	Cr_5Al_8	26*R*
Po (β)	1b*R*	Mg_2Cu	48*Q*	Co_2Al_5	28*H*
Se (α)	32*M*a	$ThSi_2$	12*U*b	Th_6Mn_{23}	116*F*b
Se (β)	32*M*b	$CoGe_2$	24*S*	Sigma	30*T*b
				$Mg_2Cu_6Al_5$	39*C*
NaCl	8*F*b	ThC_2	12*N*	Co_2Al_9	22*M*
CsCl	2*C*	Cu_2Te	6*H*e	$Mg_{32}X_{49}$	162*B*
ZnS (Sph.)	8*F*c	$LiZn_2$	3*H*d	Ir_3Sn_7	40*B*b
ZnS (W)	4*H*b			Mg_3Ga_2	28*P*
NiAs	4*H*c	$CoAs_3$	32*B*	W_2B_5	14*H*
Ni_2In	6*H*a	BiF_3	16*F*b	Mo_2B_5	7b*R*
HgS	6*H*b	ReO_3	4*C*	Th_7Si_2	19*H*
LiOH	4*T*b	Fe_3C	16*O*b	FeAsS	24*N*
PbO	4*T*c	Na_3As	8*H*b	CuFeS$_2$	16*U*e
NiS (Mill.)	6*R*a	Mg_3Cd	8*H*c	$MgCuAl_2$	16*S*
GeS	8*O*b	$NiAl_3$	16*O*c	AuAgTe$_2$ (Sylv)	12*M*
PtS	4*T*d	Cu_3P	24*H*b		
CuS	12*H*a	TiAl$_3$	8*U*		
AuCd	4*O*	$ZrAl_3$	16*U*c	Fe_3W_3C	112*F*b
FeSi	8*C*b	T…iNi$_3$	16*H*a	Al_3C_3N	18*H*b
FeB	8*O*e	$TiCu_3$ (β)	8*O*h	$FeCu_2Al_7$	40*H*
		Ag_3Ga (γ)	9*H*d	$Fe_3Mg_3Al_8Si_6$	18*H*c
SnS	8*O*d	U_3Si	16*U*d	Mn_3Al_9Si	26*H*
MnP	8*O*e	Mn_3As	16*O*d	$AlLi_3N_2$	96*B*
NaTl	16*F*a			$CuFe_2S_3$	24*O*b
PdS	16*F*	$BaAl_4$	10*U*a		
CoSn	6*H*c	$MoNi_4$	10*U*b	NiSbS	12*C*b
TeSe	16*U*a	UAl_4	20*P*	NaHF$_2$	4*R*
UCo	16*B*	$PtSn_4$	20*S*	CuSbS$_2$	16*O*e
AgZn	9*H*a	$PtPb_4$	10*T*a	KFeS$_2$	16*N*
CaSi	8*S*b	UB_4	20*T*		
NiSi (η)	8*O*f —	Mn_4B	40*Q*	Spinel	56*F*b
CdSb	16*O*a	B_4C	15*R*	Cu_3VS_4	9*C*
CrB	8*S*c			$FeCu_2SnS_4$	16*U*f
MoB	16*U*b	CaB_6	7*C*	Mo_2Ni_3Cr	56*O*
WC	2*H*b	$NaZn_{13}$	112*F*a		
MoC (α)	8*H*a	$TiBe_{12}$	624*H*		
BN	4*H*d	$ThMn_{12}$	26*U*		
AsS	32*M*c	U_6Mn	28*U*		
TiB	8*O*g	$CaCu_5$	6*H*f		
		$BaHg_{11}$	36*C*		
CaF_2	12*F*a	UB_{12}	52*F*		
MgAgAs	12*F*b	Fe_3N	18*U*		
FeS_2 (Pyrite)	12*C*a	La_2O_3	5*H*a		

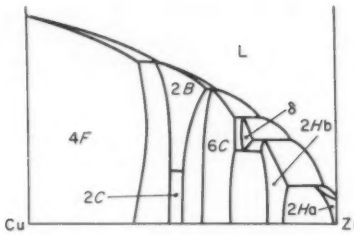

Fig. 1.—Schematic Cu-Zn phase diagram with the phases identified according to the proposed phase nomenclature.

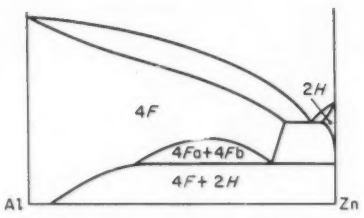

Fig. 2.—Schematic Al-Zn phase diagram with the phases identified according to the proposed phase nomenclature.

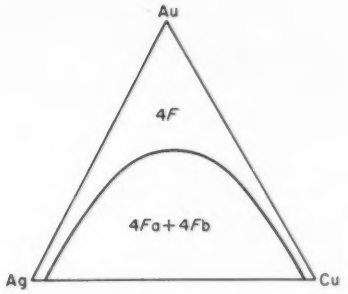

Fig. 3.—Schematic isothermal section of the Cu-Ag-Au phase designations as proposed.

the structure is determined with certainty, the Greek letter in the phase designation may be replaced by the corresponding structure symbol.

APPENDIX

1. F. N. Rhines contributed the following comments on the system of nomenclature described and proposed another system to replace it. His main points were as follows:

Crystal structure is irrelevant from the point of view of nomenclature, since phases are defined not by properties, such as structure, hardness or color, but in terms of uninterrupted composition-temperature-pressure fields in phase diagrams. It is futile to attempt to reconcile the discrepancies that must arise from using an atomistic basis for naming species of a thermodynamic concept. Instead, an arbitrary system of naming phases will be the most satisfactory, such as the following:

(*a*) Designate all terminal phases by chemical symbols, using Greek subscripts to distinguish among allotropes.

(*b*) Designate all intermediate phases by appropriate sequences of chemical symbols, and distinguish among intermediates in the same sequence by the use of Greek or numerical subscripts.

(*c*) For isomorphous series, use hyphenated designations made up of the symbols for all of the terminal phases of the series.

(*d*) Establish a clearinghouse of nomenclature where each newly found phase may be registered with its assigned name.

2. The point has been raised that the structure symbols suggested, sometimes imply similarity between dissimilar phases (for example 8a*F*, 8b*F* and 8c*F* are dissimilar structures), and conversely, that they at times disguise similarity between analogous structures (for example the symbols 52b*B* and 52*C* are both used for gamma brass type structures).

In regard to the first item, it should be remembered that the same Bravais lattice and the same number of atoms per unit cell certainly does not assure that the structures are the same. The example cited to illustrate the second item may be used to point out that the two structures, although related, are indeed different. This may be seen, for instance, if the number of atoms per unit cell is replaced in both cases by the numbers of equivalent atoms in the various lattice positions 12,8,8,24*bB* and 6,6,4,4,4,4,12,12*C*.

3. It has been pointed out that the symbols for phases related to each other by an order-disorder transformation do not show this relationship (for example see Fig. 1).

4. The lower case letters used to differentiate between various structures with the same Bravais lattice and the same number of atoms is arbitrary. Considerable thought was given by various members of the subcommittee to the desirability of using instead symbols describing some characteristic features of the structures concerned. However, in the end the conclusion was reached that this particular arbitrary part of the otherwise meaningful nomenclature could not be eliminated without unduly increasing the number of digits used and complicating the structure designation to an extent that would make it impracticable.

5. The view has been expressed that it would be preferable to use the familiar Strukturbericht symbols, rather than to introduce a new system for designating crystal structures. This question has also been given considerable attention in the discussions of members of the subcommittee. The conclusion has been reached by those participating in these discussions that the suggested system of structure designation was decidedly superior to the old Strukturbericht scheme, being much less arbitrary and conveying in an easily memorized symbolism a great deal more information relating to the structure. Since in the Structure Reports published after the war Strukturbericht type symbols have no longer been assigned to newly discovered structures, it was concluded that the changeover to the new, more meaningful, system of structure designation could be successfully accomplished in the near future.

6. An extensive report was made available to the subcommittee, proposing an alternative scheme of structure designation based on "lattice complexes," or physically equivalent sets of points in the lattice. Much meaningful information can be transmitted by a designation that indicates all the lattice complexes present in the structure considered. Despite the undeniable value of such a system of designations, it was concluded that the length and complexity of these designations (for example C16161927 for gamma brass and CO517244244 for alpha manganese) would prevent their use in a practical phase nomenclature. Although these designations certainly give a much more complete description of the structure than those suggested above, for the limited purposes of a unique phase designation the additional information is not necessary.

Constant Head Rate Testing Machine with Instantaneous Speed Change*

By M. J. MANJOINE, E. T. WESSEL, and W. H. PRYLE

Speed changes as large as 1 to 1,000,000 with and without intermediate steps can be continuously changed as a function of time or strain over a range of 1 to 100,000.

In the study of the strength of materials and of the mechanisms of flow and fracture, the influence of the rate of strain is paramount. Ludwik (1)[1] in his early work on tin wires at normal temperatures pointed out that the ultimate strength increases as the logarithm of the strain rate. This relationship was confirmed over a limited range of rates for other materials at elevated temperature by Nadai, *et al* (2). This latter work also pointed out that for some materials over a range of temperatures, the relationship between stress and strain rate can be expressed as a power function or as a hyperbolic *sine* function.

Perhaps no other mechanism of flow has received more attention than that of the yield point of mild steel. The influence of rate of loading and the rate of straining on the yield stresses of mild steel has been pointed out by Davis (3) and Manjoine (4). As early as 1909, Le Chatelier (5) showed that in low-carbon steel the maximum in the ultimate strength as a function of temperature could be shifted to a higher temperature level by increasing the speed of testing. MacGregor, *et al* (6), using the data of M. J. Manjoine (4), illustrate that the aging peak followed a velocity-modified temperature based on the chemical rate theory. Zener, *et al* (7), also showed, from the data of Nadai, *et al* (2), of the strength as a function of strain rate and temperature, that the heat of activation for the flow mechanism could be calculated for copper and steel for a given temperature range.

Strength of Materials

From the above it can be seen that the strength of a material depends to a large extent on the rate of deformation. In engineering applications, the rate of deformation may extend from impact or explosion rates to very low creep rates. For design, the engineer must use the value of strength corresponding to the rate of loading encountered in service. It has also been pointed out that different types of tests of a material can be

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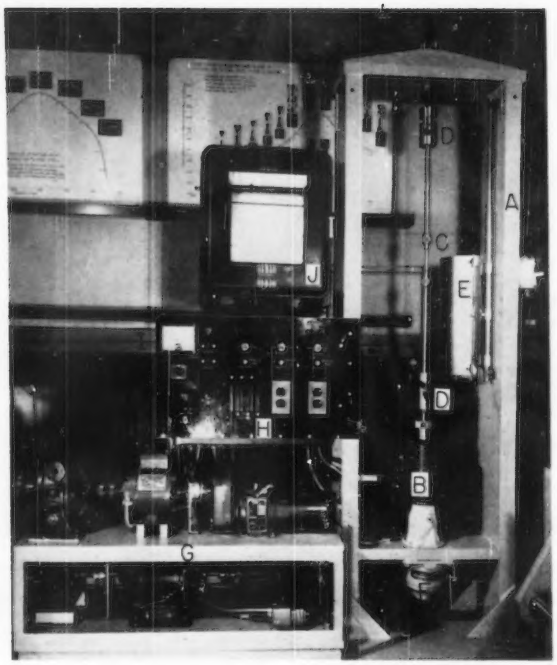
*Presented at the Sixtieth Annual Meeting of the Society, June 16–21, 1957.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.



A—Heavy frame
B—Electric force gage
C—Test specimen
D—Aligning joints
E—Furnace
F—Screw jack for lower head motion
G—Adjustable speed drive system
H—Control panel
I—Head rate indicator
J—Autographic recorder of load and deformation

Fig. 1.—Constant strain rate machine.

correlated if compared at the same rate of deformation (8).

Equally important is the study of the mechanisms of flow and fracture of metals. The activation energy of a flow process can be obtained in many cases from data of constant strain rate tests over a range of temperatures. If a change in the mechanism of flow occurs as a result of strain aging or precipitation, discontinuous yielding is observed and the flow stress will decrease with increasing rate of strain (4,9). In the exploration of this phenomenon it is desirable to vary the strain rate with time at a constant temperature.

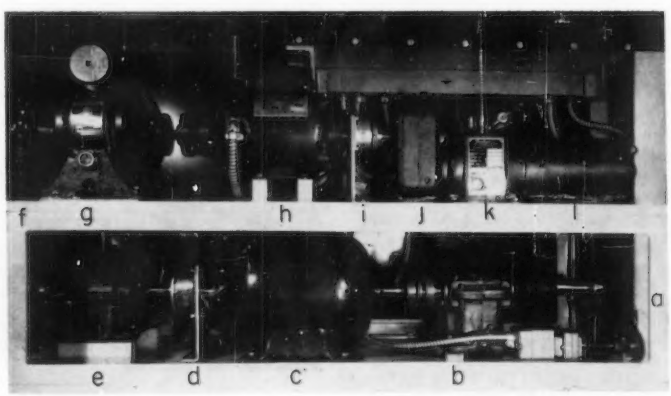
The mode of fracture at both low and elevated temperatures shows a transition from ductile to brittle. For most of the body centered-cubic and some close-packed-hexagonal metals of commercial purity, the low-temperature ductile-to-brittle transition is a continuing problem (10). Strain rate is known to have considerable influence in determining the temperature range in which the low temperature ductile-to-brittle transition occurs; increasing the strain rate raises the transition temperature. It is believed that this effect is primarily due to the increase of the generally applied stress level during the early stages of plastic flow (10,11). Strain rate is also thought to be an influential factor in the high-temperature ductile-to-brittle transition. At elevated temperatures high alloy steels have been observed to fail with low ductility at slow deformation rates (12).

Testing Machine

Based on the above discussion, some of the desirable features for a universal type constant head rate testing machine are as follows:

1. A change in the rate of deformation which is logarithmic.
2. A quick change from one rate to another to prevent stress relaxation during changeover.
3. A quick reverse to unload and thus prevent further plastic flow. A reverse is also desirable to reduce the stress before initiation of a second rate of deformation.
4. A continuously variable rate of deformation over a wide range for purposes of exploring changes in the mechanisms of flow or fracture.
5. A variation in load scale ranges with provisions for a quick change of load range.
6. Autographic recording of load and deformation.
7. Means of heating and cooling test specimens.
8. A stiff machine with axial loading.
9. Continuous indication of rate of deformation.
10. Ease of operation.

With the above points in mind, a constant strain-rate testing machine of 20,000 lb maximum capacity was designed. The machine is pictured in Fig. 1. The features 1 to 4 given above have been incorporated in the drive of this machine, *F* to *H* in Fig. 1. The screw jack, *F*,



a—Input shaft to the jack
b—Fixed speed reducer 9:1
c—1 1/2 hp constant-speed motor No. 1
d—Magnetic clutch
e—Fixed speed reducer 9.5:1
f—Belt and pulley, 1:1 (changeable to 3:1)
g—Speed variator 1:3 to 3:1
h—1/2 hp constant-speed motor
i—Magnetic clutch
j—Speed reducer 8:1
k—Adjustable speed transmission 1:1 to 1500:1
l—1/4 hp constant speed motor

Fig. 2.—Adjustable speed drive.

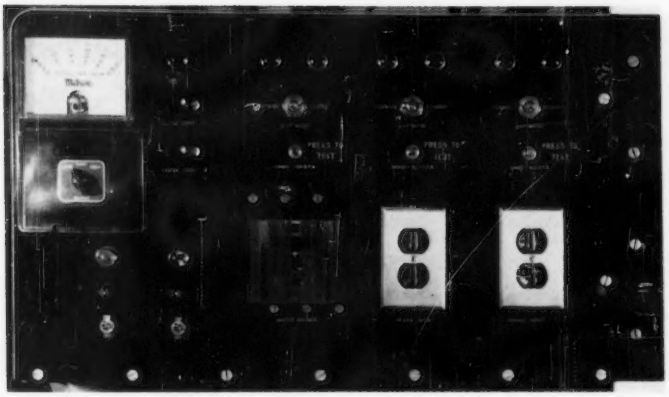


Fig. 3.—Control panel.

converts a rotary motion of its input shaft to a linear motion of its jack shaft, (96 revolutions = 1 in.). A close-up of the adjustable speed drive is shown in Fig. 2.

An instantaneous change from one drive motor to another is accomplished by interlocking electrical controls. A closeup of the control panel, Fig. 3, shows the push buttons to control each drive motor. The switch above the button allows the presetting of the direction of rotation or the reversing of a motor. When one of the buttons is pushed, its motor and the clutches between this motor and jack are energized; any other motor and clutches are automatically de-energized. The motors may be operated in any sequence and in either direction of rotation. Thus, the test specimen may be unloaded rapidly or the machine head may be quickly returned to starting position for subsequent testing. The head rate indicator is located at the top left of the panel, Fig. 3. It is used to check the head speed during test for the intermediate range. The pick-up for the head rate indicator is at the extreme lower right in Fig. 2. A manual switch (lower left in Fig. 3) is provided for magnetic clutch *d* so that the setting of the variable speed reducers can be changed with or without head motion.

The table below lists the head rates available from this drive system.

Drive	Motor	Head Rate, in. per hr.	
		3:1 Pulley	1:1 Pulley
High	1½ hp	120 (fixed)	120 (fixed)
Intermediate	½ hp	13——1.3	39— 3.9
Low	¼ hp	1.5——0.0001	4.5—0.0003

Other variations in the head rate for the different drive motor ranges are readily accomplished by using other pulley ratios or variable speed motors.

As mentioned earlier, the flow stress for many materials varies as the logarithm of the strain rates. It is, therefore, necessary to vary the rate by a large factor, such as 10 or 100, to detect a significant change in the flow stress. If the intermediate drive is set at 12 in. per hr and the low at 1.2, then three speeds can be obtained in steps of 10:1 just by pushing the control buttons. By setting the intermediate drive at 1.3 in. per hr and the low drive at 0.012 then steps of about 100: 1 are obtained.

To cover a large variation in load, the high-speed autographic recorder (*J* in Fig. 1) is equipped with four ranges: 2000, 4000, 10,000 and 20,000 lb; it can be switched from one range to any other during a test. The load can be recorded as a function of head displacement, time, or strain. The head displacement drive is connected to the jack shaft (*a*, Fig. 2) through an adjustable gear reducer. A synchronous drive can be substituted to record force as a function of time.

The foregoing description provides the essential details incorporated in the basic machine to provide control of the important variable: strain rate. Apparatus for the control of additional important variables has been adapted to the machine in the form of accessories. Temperature is one of these additional variables provided. Elevated test temperatures from room temperature to 2200 F are achieved using a more or less conventional furnace of 3 windings with independent power supplies. Apparatus and techniques for low-temperature testing (in the range from room temperature to −452 F) have been previously described (**13**,**14**). The type of loading imposed by the machine can also be varied from tension to either bending or compression by the insertion of suitable fixtures (**15**).

The capabilities of the testing machine may be summarized as follows:

Variable	Range of Control
Constant head motion	1 to 1 000 000
Instantaneous speed changes	Ratios of 10:1 (2 steps), 100:1 (2 steps), 1000:1 to 1 000 000:1 (1 step)
Test temperature	−452 to 2200 F
Loading system	Tension, compression, or bending with autographic load—deflection curves

Test Results

The versatility of this machine is demonstrated in the following test program to determine the effect of strain rate on the flow stress of a wrought 35 nickel, 15 chromium alloy steel. The composition is given below:

	Carbon	Manganese	Silicon	Nickel	Chromium	Iron
Weight, per cent	0.16	0.65	1.48	34.56	18.54	Balance

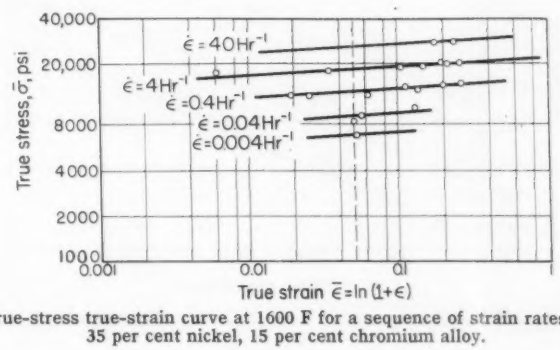


Fig. 4.—True-stress true-strain curve at 1600 F for a sequence of strain rates. Wrought 35 per cent nickel, 15 per cent chromium alloy.

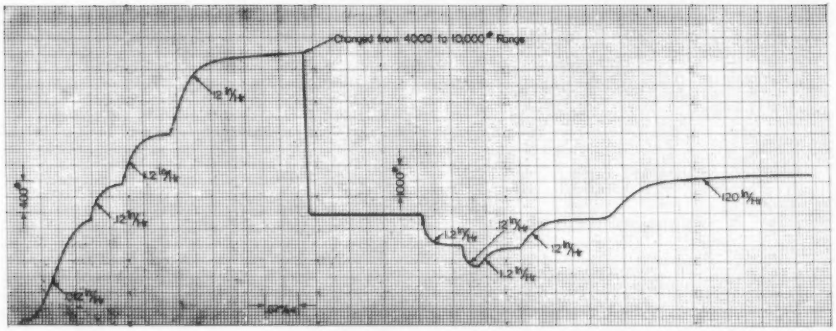


Fig. 5.—Autographic curve at 1600 F for Ni-Cr alloy.

The alloy was tested in the "as-forged" condition (DPH-158). The test specimens had a gage section of 0.505 in. diameter by 3 in. long.

Tests were performed at 1300, 1450, and 1600 F. The following test procedure was normally used. After the temperature was stabilized for about 1 hr, the specimen was loaded at an intermediate strain rate to determine the flow stress range setting. The specimen was then partially unloaded by reversing the head motion. Head rates of 0.012, 0.12, 1.2, 12, and 120 in. per hr were applied in this sequence and followed by a sequence of decreasing head rates. The specimen was strained at each head rate to establish a flow stress.

The flow stress of a material is that stress under which the material will deform plastically. It is, however, a function of the following factors (**8**): (1) strain, (2) rate of strain, (3) temperature, (4) metallurgical state, and (5) state of stress. For this "as forged" wrought 35 per cent nickel, 15 per cent chromium alloy the flow stress under uniaxial tension at 1600 F for several strain rates applied in sequence is a function of the plastic strain as given in Fig. 4. For each point of this figure the true flow stress was calculated from the load reading taken after the flow had reached a state of equilibrium for the given head rate. When this equilibrium was reached the next head rate in the sequence was applied. A portion of the autographic load-deflection curve from which these points were obtained is reproduced in Fig. 5. At 1600 F it can be seen that equilibrium of flow is established after a small plastic strain following the elastic strain which accompanies the change in flow stress. At this equilibrium of flow the slope of the load-deflection curve is approaching zero; the strain rate under this condition is equal to the head rate divided by the effective gage length. Since some strain recovery occurs with a decrease in flow stress, equilibrium was more quickly established for an increase in strain rate than for a decrease. At 1600 F Figs. 4 and 5 show that recovery is small and that the change in flow stress is large for a change in strain rate of 10 to 1. At the lower temperatures, however, the strain recovery was large so that only the flow stresses for a sequence of increasing strain rates were utilized.

To determine the flow stress as a function of strain rate, the flow stress must be measured at a given temperature, strain rate, and plastic strain. Since these tests were performed with a sequence of strain rates, a particular flow stress must be evaluated by interpolation of true-stress true-strain curves similar to those of Fig. 4. For example, the flow stress of this wrought alloy at 1600 F and at a natural strain of 0.05 is given by the intersection of the dashed line of Fig. 4 with the curve for a given strain rate. A comparison of the log of the flow stress at this true strain of 5 per cent is given as a function of the log of the strain rate in Fig. 6 for the various test temperatures. These flow-stress curves indicate that this alloy follows a linear relationship over this temperature range. The true flow stress, $\bar{\sigma}$ at 5 per cent strain can be expressed as a power function of the strain rate, $\dot{\epsilon}$, as follows:

$$\frac{\bar{\sigma}}{\sigma_0} = \left(\frac{\dot{\epsilon}}{\dot{\epsilon}_0}\right)^m$$

where σ_0 and $\dot{\epsilon}_0$ are functions of the temperature and m has a value of 0.147 for stresses below 30,000 psi. The curve for 1300 F shows a change of slope at 30,000 psi. This indicates a change in the mechanism of flow which is dependent on both stress and strain rate.

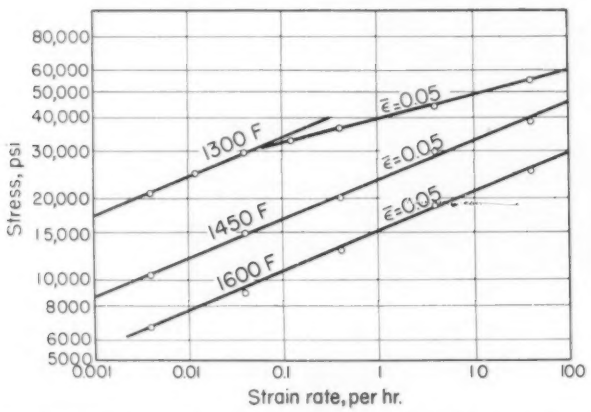


Fig. 6. True stress *versus* strain rate. Wrought 35 per cent nickel, 15 per cent chromium alloy.

Summary

A testing machine has been described in which the head motion can be instantaneously changed in direction or in speed over a range of 1,000,000 to 1. This machine will enable the research scientist to apply new techniques in the study of flow and fracture of materials from subnormal to elevated temperatures. The use of this machine as a research tool is demonstrated in the plastic flow characteristics of a 35 per cent nickel, 15 per cent chromium wrought alloy.

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DISCUSSION

Mr. R. K. Bernhard[1] (*presented in written form*).—The authors have developed a testing machine which is of great value, in particular for any investigations referring to the yield range of elastic materials. The constant head rate[2] with instantaneous speed change will enable further studies on the significance of upper and lower yield points.

The dynamic characteristics of their machine, for example the elastic coupling between frame, gripping mechanism, loading system, etc., and specimens are of primary importance. Some data on the ratio of spring and damping characteristics[3] between this machine and various specimen sizes would be of interest.

[1] Rutgers University, College of Engineering, Bureau of Engineering Research, New Brunswick, N. J.

[2] R. K. Bernhard, "Automatic Speed Control for Tension and Compression Testing Machines," ASTM Bulletin, No. 106, Oct., 1940, p. 31.

[3] R. K. Bernhard, "Influence of the Elastic Constants of Testing Machines," ASTM Bulletin, No. 88, Oct., 1937, p. 14.

Mr. M. J. Manjoine (*author*).—Mr. Bernhard has pointed out that stiffness and damping are of primary importance in determining the dynamic characteristics of a testing machine. The spring constant of our machine with its standard tension grips is about 100,000 lb per in. The stiffness of the frame and loading system is much higher, but this stiffness is reduced by the test specimen and long slender extension pieces. The latter are so made to cut down the conductive losses when the high-temperature furnace or low-temperature chamber are employed.

A stiff machine, that is, one with high spring constant, is desirable when yield point phenomena or discontinuous yielding are studied. For such a machine, a large drop in load is observed for a small amount of yielding. Therefore, extension pieces with large cross-sections should be used for tests in which yielding may occur.

Damping is necessary to prevent load oscillations in the testing machine and recording system when yielding occurs. In the early machines, the recording system was a mechanical one, usually with a low natural frequency. To prevent mechanical oscillations of the recording stylus or pen it was necessary to introduce damping. In many cases this resulted in recording errors when sudden yielding was encountered. Our machine is similar to many current machines that record load through the use of electric signals from load cells. These cells are very stiff compared to mechanical lever systems. The damping is introduced electrically in the load recorder. Thus, it is possible to damp out critically any oscillation excited by sudden yielding or to prevent overshoot or undershoot when the load rate is suddenly changed. The latter may be a result of either the flow characteristics of the test specimen or a change in the head rate. Damping introduced electronically has resulted in a load recording which is much more accurate than that obtained from mechanical systems.

Ultrasonic Testing of Aluminum Alloys*

By WILLIAM L. FINK

Acceptance standards should be based on a zoning principle that requires the most rigid standards for the extremely small critical regions in which there are high stress concentrations and in which the plane of the discontinuity lies perpendicular to the direction of loading

ULTRASONIC testing procedures (in most cases based on the reflection of ultrasound from interfaces in the part being tested) usually enable one to detect the presence of small discontinuities, even in very large parts—discontinuities that one could not hope to find by any other nondestructive method. Because of this, ultrasonic testing was adopted for the inspection of aluminum products about twelve years ago. At first it was used in a qualitative way to aid in the improvement of casting and fabricating procedures and to remove defective material at the earliest possible stage of fabrication.

The use of ultrasonic inspection expanded constantly during the ensuing years and contributed substantially to the ever increasing quality of aluminum alloy products. More recently, ultrasonic testing has been used to inspect the final product, either on a sampling basis as a quality control measure or on a 100 per cent inspection basis. The latter is applied principally to products used for the construction of aircraft where the assurance of quality is particularly important. Because of its usefulness in both of these fields, the volume of ultrasonic inspection in the aluminum industry has increased very rapidly during the past few years.

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* Presented at the Sixtieth Annual Meeting of the Society, June 17–21, 1957.

Standardization

The qualitative methods initially used were, of course, inadequate for final inspection. Rejection limits had to be set up and this in turn necessitated the standardization of instruments and methods. The usual basis for such standardization is the use of reference blocks (blocks of aluminum alloy in which flat bottomed holes of various diameters are drilled). Subcommittee VI of ASTM Committee E-7 on Nondestructive Testing has made progress towards setting up ASTM standard reference blocks. In the meantime, the industry has used blocks made by the Aluminum Company of America for the Airframe Committee of the Society for Nondestructive Testing, or blocks made by the Ultrasonic Testing and Research Laboratory. The Alcoa ultrasonic standard reference blocks consist of two series—A and B. Blocks of both series are made from 2 by 2-in. rolled rod of 2014-F alloy. The series A blocks are each $3\frac{3}{4}$ in. long with a $\frac{3}{4}$-in. deep flat-bottomed hole drilled axially in one end. The holes in these blocks vary in diameter by $\frac{1}{64}$ in. increments from $\frac{1}{64}$ to $\frac{8}{64}$ in. These blocks are very useful in adjusting the instruments so that different sized holes give different sized pips and so that consistent results can be obtained from time to time and from plant to plant. These blocks provide a common basis for expressing the results of ultrasonic inspection, since each standard block has been calibrated against and has been made to provide responses equal to those from a master block.

Figure 1 shows the relation between the height of the pip seen on the screen of the instrument and area of the bottom of the hole in series A Alcoa ultrasonic standard reference blocks for a UR reflectoscope that is in good adjustment. Each curve represents a different gain setting. It will be noted that up to a pip height of about 2 in. peak-to-peak (for the instrument used in this experiment) there is a nearly linear relation between the pip height and the area of the bottom of the hole. As the gain of the instrument is increased, the linear relationship between the pip height and the area of the bottom of the hole is restricted to fewer and fewer blocks.

The series B blocks have only three hole sizes $\frac{3}{64}$, $\frac{5}{64}$ and $\frac{8}{64}$ in. in diameter. In an up-to-date set of B blocks, there are eleven different metal distances

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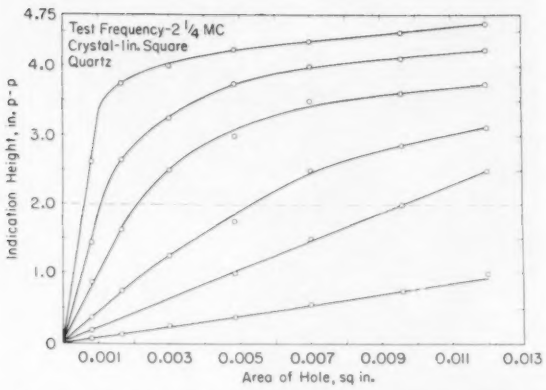

Fig. 1.—Relation between pip height and area of bottom of hole.
Alcoa series A ultrasonic standard reference block.

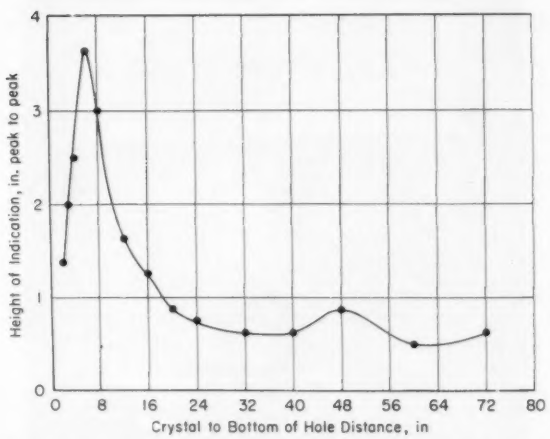

Fig. 2.—Relation between pip height and distance to discontinuity.
Reflection was obtained from a 3/64-in. diameter flat bottomed hole in 2014-F rolled bar, using a 5-Mc 1 1/8-in. diameter crystal.

(from $\frac{1}{4}$ to 6 in.) for each hole size. These blocks are used to check the resolving power and the penetration, as well as to correct the pip height for metal distance. They may also be used to evaluate searching units. Figure 2 shows a curve that was obtained with a set of *experimental* B blocks having metal distances up to 72 in. It will be noted that the pip height rises rapidly to a maximum and then decreases (approximately exponentially) as the distance from the surface to the discontinuity increases. The part of the curve to the left of the maximum (that is, up to about 6 in. on this curve) represents the "close field" or "near field," whereas the part of the curve to the right of the maximum represents the "far field." The shape of the curve in the far field is determined principally by the attenuation of the ultrasound as it passes through the material. The distortion of the curve in the far field producing a secondary maximum at 48 in. is attributed to reflection of the diverging beams from the side walls of the relatively narrow (2 by 2 in.) bar. The shape of the curve in the close field and the location of the maximum depend upon several factors such as instrument recovery time, phase relations between the ultrasound reaching various portions of the crystal, and the Fresnel effect.

It is obvious that the effect of distance on pip height is so great that in most careful testing a correction should be made for this distance.

The extent of the close field is shown in Fig. 3. It can be seen that with the use of the higher frequencies (used extensively today) and the use of large diameter crystals to speed up inspection, a large per cent of the material will be inspected in the close field.

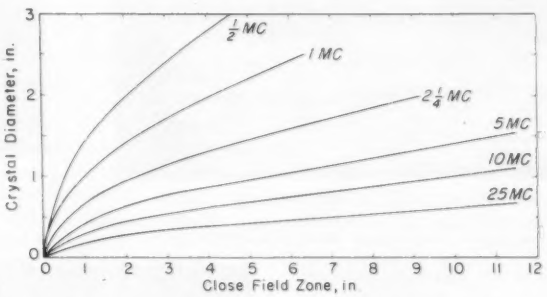

Fig. 3—Close field relationships for aluminum.

An accurate, direct experimental procedure for correcting the pip height for distance is to compare it with that from a B block of the correct length. This is the best method for specification or referee purposes. It can also be used for laboratory investigation or for the routine inspection of limited quantities of material. However, it is slow, and for the routine inspection of large quantities of commercial production, a more rapid method is essential.

A simple, obvious solution of this problem is to determine the curve of pip height *versus* distance for the maximum permissible discontinuity in any given product and equipment and then to inspect against that curve plotted on a transparent plastic sheet attached to the face of the oscilloscope tube. The indications are observed visually, and any pip going above the curve justifies rejection. It is also possible to exhibit the desired curve on the screen electronically.

These methods are much faster than direct comparison with B blocks. However, the scanning must be sufficiently slow to allow visual observation of the heights of all pips. Some products with simple shapes such as plate, rod, and bar can be scanned at much higher rates if the indications are electronically monitored and an audible signal automatically given when the indications exceed the permissible limits. These permissible limits should, of course, be determined by the appropriate curve of pip height *versus* distance as described above. The electronic monitor should automatically correct according to this curve. Alcoa has developed and is using monitors of this type.

The use of the curve for visual inspection or the use of the monitor is successful only if all equipment is standardized, because the shape of the curve is affected substantially by the type of ultrasonic instrument used, the instrument alignment, the characteristics of the searching unit, length

Fig. 4.—Discontinuity in forged 7075 bar. × 4
Two bright rounded areas are unhealed porosity. Heat treatment opened up rest of triangular area of discontinuity.

Fig. 5.—Discontinuity in forged 7075 biscuit. × 20
Dross inclusion. Outlined by a black crayon mark.

of cable, type of matching network, etc. The ultrasonic instruments are checked and aligned using a signal generator and an oscilloscope to check for pulse voltage, pulse length, receiver sensitivity, frequency, and band width at all test frequencies. Whenever any of these is found to be outside certain limits (that have been set up in cooperation with the instrument manufacturers) adjustments are made to bring it within the required limits. Searching units can be calibrated by means of series B blocks. Those searching units giving the same curve of pip height *versus* distance are then used interchangeably. Finally, after standardization of all equipment, readings are made on series B blocks to be sure that the curve of distance *versus* pip height is standard.

Discontinuities

Nearly all interfaces within the material being inspected will reflect some of the ultrasound reaching them. The percentage of the energy reflected at any interface will depend upon the difference in density and elastic constants between the materials on either side of the interface. For example, at an air-metal interface the reflection closely approaches 100 per cent. The percentage of energy reflected from interfaces between aluminum solid solution and intermetallic compounds of aluminum, or between two aluminum solid solutions with different compositions, or between two regions with different grain orientations is very small. Usually they do no more than produce a myriad of very small overlapping pips that form the low hash[1] pattern of sound material. However, in exceptional cases, such an interface may be sufficiently flat and extensive to produce relatively large pips that may be mistaken for harmful discontinuities.

Usually, the larger pips (for example, those exceeding in height the pips that are obtained from a $\frac{3}{64}$-in. diameter flat bottomed hole) indicate discontinuities that arise from porosity or dross inclusions in the original ingot. Figures 4 to 6 illustrate discontinuities that were indicated by ultrasonic inspection and found by fracturing the piece through the indicated location.

Fig. 6.—Discontinuity in 7075 hand forged used in fatigue tests. × 10
Most discontinuities in fatigue fractures the same except for size and shape. This figure shows one of the elongated discontinuities.

[1] The term hash refers to the relatively small indications occurring along the trace line in such numbers that they are not resolved. General porosity will produce a higher hash level than will the structural features considered here.

The effect of working the metal (for example, forging or rolling) has a marked effect on the cross-sectional area of the discontinuities and hence the sizes of the pips that appear on the oscilloscope screen. A small pore in the ingot (one that merely contributes to the hash pattern on the screen) will be flattened or extended during working (if it does not "heal") so that a sizable pip is obtained. The thinner the plate or the web of a forging, the greater the area covered by a given discontinuity and hence the larger the pip on the screen. This is a fact that must be taken into consideration in setting up acceptance standards.

Under some conditions it is possible to get such intimate contact between the metal on either side of a flattened pore that very little ultrasound is reflected. Such contacts are frequently destroyed by solution heat treatment or normalizing. Consequently, a more critical inspection may be obtained after such thermal treatments. It is sometimes possible to distinguish on the fracture those areas that were in intimate contact before heat treatment and those that were not. Figure 4 is an example. The two bright areas of the discontinuity contributed to the pip obtained prior to heat treatment whereas the whole area of the discontinuity contributed to the pip after heat treatment.

It should be realized that the height of the pip on the oscilloscope screen is not a quantitative measure of the size of a discontinuity. The height of the pip is influenced by factors other than area, such as the roughness of the interface that reflects the ultrasound, the relative impedence of the material on either side of the interface, the angle of the defect, the contour of the piece, and the frequency of the ultrasound. Although correction can be made for some of these factors, it is impossible for others. Nevertheless, reasonable acceptance standards that assure the general quality level of the material can be set up on the basis of corrected pip height.

Effect of Discontinuities on Properties

As with all nondestructive testing methods, it is necessary to gain enough background so that the findings can be intelligently evaluated. Primarily, it is necessary to know which of the discontinuities are detrimental and which are not. It is not easy to answer this question, because the effect of discontinuities on properties depends upon so many factors—the size and the shape of the part, the property being considered, the type of material, the location and the orientation of the discontinuity, and the way in which the part is stressed. Nevertheless, enough work has been done to justify some generalizations.

In regard to tension tests, it has been found that the usual discontinuities of unhealed porosity and oxide film have no appreciable effect upon the tensile properties when the stress is applied parallel or nearly parallel to the plane of the discontinuity. When the stress is perpendicular to the plane of the discontinuity, the strength of the specimen is decreased. The decrease is a function of the percentage of the cross-sectional area occupied by the discontinuity. However, the decrease is somewhat greater than would be predicted on the assumption that it is proportional to the percentage of the area occupied by the discontinuity.

In regard to fatigue life, it has been shown that discontinuities giving pip heights less than that obtained from a $\frac{5}{64}$-in. hole will have no measurable effect on the fatigue life of a smooth specimen stressed in direct tension if the part is stressed parallel to the plane of the discontinuity. It was found that such discontinuities perpendicular to the stress did reduce the fatigue life. The question then naturally arose as to the relative effect of discontinuities and stress raisers inherent to the design of structural parts. Work is in progress at the Alcoa Research Laboratories to answer this question, and a brief synopsis of some of this work is presented below.

The study was conducted in the following way. A lug-type specimen, illustrated in Fig. 7, was selected as a simple structural component that could be machined out of a hand forging in such a way that discontinuities revealed by ultrasonic examination would be in desired locations. The specimens were stressed in tension by means of steel pins passing through the holes and through clevis-type fixtures in the fatigue machine. The holes represented a typical stress-raising design feature. It is estimated from the literature that the stress concentration factor was about 3.5.

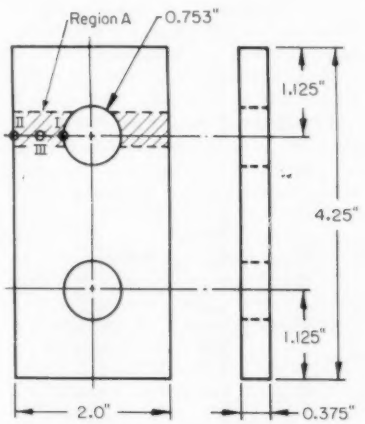

Fig. 7.—Lug specimens.

The specimens were cut from a rectangular 7075 alloy hand forging that had been scrapped on the basis of ultrasonic inspection. The piece used in this investigation (approximately $5\frac{1}{4}$ by 7 by 16 in.) was machined from the forging that had been heat treated and aged at the original thickness of $5\frac{1}{2}$ in. A thorough ultrasonic examination of the heat-treated piece was conducted by the immersion method using a $\frac{3}{8}$-in. diameter 10 Mc searching unit and scanning along lines spaced $\frac{1}{8}$ in. apart. This examination revealed 111 discontinuities giving indications distinctly above the hash level. The indications ranged from less than that obtained from a No. 3 reference block to greater than that obtained from a No. 5 reference block (the height of indication was measured in all cases with the searching unit angulated for maximum response). A high hash level—up to 20 per cent of the indication from a No. 3 block at the metal distance involved—indicated the presence of interfaces giving indications between those from a No. 1 and a No. 2 block.

Two regions were selected for the preparation of specimens, one region which contained many discontinuities giving pips above the general hash level (some giving indications exceeding that from a No. 5 block) and the other containing only the discontinuities producing the hash pattern.

Lug-type specimens were machined from both areas in the three principal directions. For two of these directions the plane of the discontinuity lay parallel to the direction of stress. In this case, the discontinuity had no effect upon the fatigue life. Specimens cut in the third direction, that is, so that the plane of the discontinuities lay perpendicular to the applied stress, will be considered in greater detail.

Some of the specimens from the less sound region contained discontinuities giving ultrasonic indications of 98 to 121 per cent of that from a No. 5 reference block. These specimens were cut so that the observed discontinuities would lie in the minimum section of the specimen, some at the edge of the hole (location I of Fig. 7) some at the edge of the specimen (location II) and others between the edge of the hole and the edge of the specimen (location III).

Other specimens were taken at random, that is without regard to the location of discontinuities revealed by ultrasonic inspection.

The specimens from the sounder region contained, of course, only the discontinuities contributing to the hash and could not be cut to place discontinuities in desired locations. However, these discontinuities were sufficiently numerous that by chance all but one of these specimens contained discontinuities in the fractures. The results were all analyzed on the basis of discontinuities observed in the fracture.

Fatigue tests on these lug-type specimens were made in a Krouse 15,000-lb capacity direct-stress fatigue testing machine. The loads were applied parallel to the long dimension of the specimens. The stress varied from 0 to a maximum in tension and back to 0.

The results of the fatigue tests with the discontinuities normal to the stress are shown in Fig. 8. The specimen numbers are shown in the figure and in Table I which gives the size of the discontinuities observed in the fractures and the location of those discontinuities that did not serve as origins of fatigue cracks.

All of the fatigue cracks in the lug-type fatigue specimens occurred at approximately the minimum section of the specimen and in region A shown in Fig. 7. They proceeded outward from their point of origin very near the edge of the hole at approximately right angles to the direction of stress. In the case of the specimens which had discontinuities in the critical region (in the minimum section near the edge of the hole, within about 0.02 in. or less) the discontinuity served as a point of origin of the fatigue crack. In those specimens which had discontinuities at greater distances—about 0.04 in. or more—from the edge of the hole, the discontinuity did not act as the point of origin.

The specimens in which the fracture did not originate at a discontinuity have been used to define the fatigue curve of Fig. 8 that represents the fatigue strength of lug-type specimens unaffected by discontinuities. One of these specimens contained a discontinuity which extended within 0.04 in. of the edge of the hole. Even this closely placed discontinuity exerted no apparent influence upon the fatigue strength of the specimen.

In this test, even small discontinuities perpendicular to the tensile stress in region A a few hundredths of an inch or less from the edge of the hole initiated fatigue cracks and decreased the fatigue strength. The extent of the decrease in fatigue strength could not be

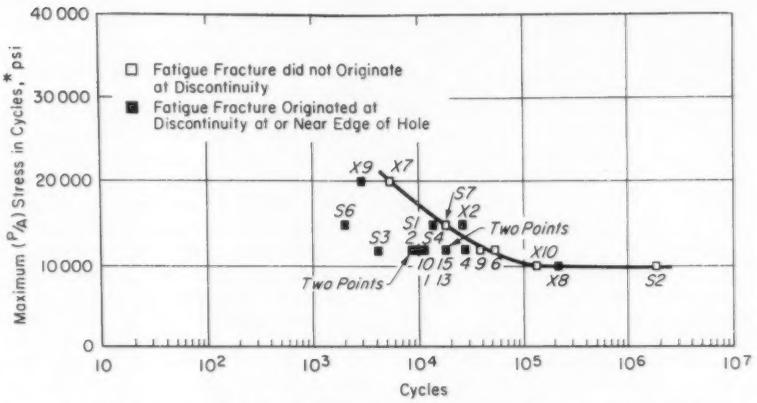
Fatigue Fracture did not Originate at Discontinuity
Fatigue Fracture Originated at Discontinuity at or Near Edge of Hole
Maximum (P_A) Stress in Cycles,* psi
Cycles
Two Points
Two Points

Fig. 8.—Axial-stress fatigue test results of lugs for normal direction of 7075-T6 hand forging.

* Net-Section Stress
** Two Points
Stress Ratio: $\frac{\text{Minimum Stress}}{\text{Maximum Stress}} = 0$

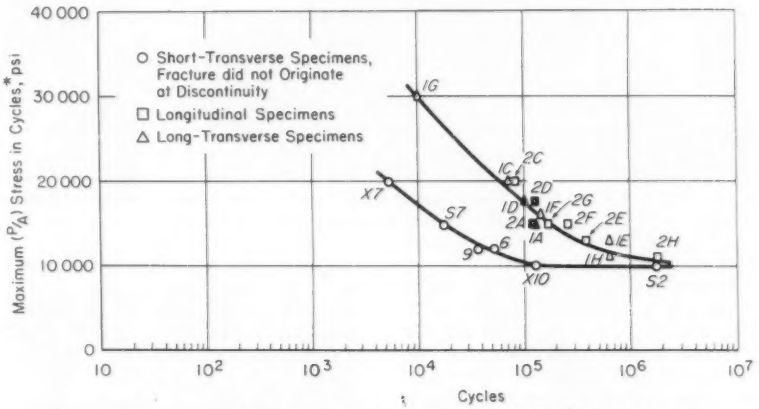

Fig. 9.—Axial-stress fatigue test results of lugs from 7075-T6 hand forging.

* Net-Section Stress
Stress Ratio: $\frac{\text{Minimum Stress}}{\text{Maximum Stress}} = 0$
Solid Symbols: Discontinuities visible in fracture, at edge of hole.

TABLE I.

Specimen	Discontinuity in Fatigue Fracture	Discontinuity Origin of Fatigue Crack	Size of Discontinuity,[a] in.	Location of Discontinuities Not Origin of Cracks
X 7	No			
S 7	Yes	No	0.062	Edge of discontinuity 0.04 in. from edge of hole in fracture.
X 2	Yes	Yes		
9	No			Discontinuity in area II at other end of specimen.
6	No			Discontinuity in area III at other end of specimen.
X 10	No			
S 2	No			
X 9	Yes	Yes	0.023	
S 6	Yes	Yes	0.042	
S 4	Yes	Yes	0.014	
S 3	Yes	Yes	0.028	
S 1	Yes	Yes	0.032	
2	Yes	Yes	0.044	
10	Yes	Yes	0.055	
1	Yes	Yes	0.096	
13	Yes	Yes	0.019	
15	Yes	Yes	0.076	
4	Yes	Yes	0.039	
8	Yes	Yes	...	

[a] Size is represented as the diameter in inches of a circle of same area.
[b] Discontinuity so narrow that area could not be measured.

correlated with the size of the discontinuity. If the periphery of a discontinuity lay more than about 0.04 in. from the edge of the hole, its effect was smaller than the effect of the hole, and it did not serve as a nucleus of a fatigue crack and did not lower the fatigue strength.

Returning now to the fatigue tests of lugs with the discontinuities parallel to the stress, the fatigue results are given in the upper curve of Fig. 9. For comparison the curve of Fig. 8 is reproduced. Three specimens (the results from which are plotted as solid symbols in Fig. 9) contained discontinuities in the fracture at the edge of the hole and in the minimum net section. However, the origins of the fatigue fractures were not located at the discontinuities. This fact and the fatigue strengths of these specimens indicated that discontinuities parallel to the direction of loading had no effect on the fatigue strength of the lugs.

These results point the way to a rational method of setting up acceptance standards for ultrasonic testing. The most rigid standards should be set up for those regions of the part in which the plane of the discontinuity lies perpendicular to the direction of loading and which are located in an extremely small critical region adjacent to the edge of a rivet hole, bolt hole, a weld, a sudden change in thickness, or other type of stress raiser. Much more liberal standards can be set up for those regions of the part in which the discontinuities are parallel to the direction of stress or in which the discontinuities lie outside these small critical regions. Acceptance standards based on this zoning principle will give maximum assurance with a minimum of cost and with the least possible interference with deliveries.

Acknowledgment:

Many men in the Alcoa Research Laboratories contributed to the investigations that serve as a basis for this paper. The author is pleased to acknowledge their assistance, particularly the contributions of C. W. Cline and J. B. Morgan in the standardization of ultrasonic testing, those of F. C. Panian in the development of the electronic monitor described, those of E. C. Hartmann and I. D. Eaton for the fatigue tests, those of Joseph Harwood for the meticulous ultrasonic inspection of the hand forging used for the fatigue test, and those of C. W. Cline, R. T. Craig and W. J. Bergmann in the study of the nature of discontinuities.

References

(1) J. B. Morgan, "Some Factors of Importance in Ultrasonic Testing," *Journal of Nondestructive Testing*, Vol. 12, p. 13.

(2) C. W. Cline and J. B. Morgan, "Standardization in Ultrasonic Testing," *Journal of Nondestructive Testing*, Vol. 13, p. 23.

(3) E. C. Hartmann, "Effect of Unintentional Stress Raisers on the Fatigue Strength of Structural Components," Presented at Second Session of International Conference on Fatigue of Metals, London, Sept., 10, 1956.

DISCUSSION

Mr. George J. Binczewski.[1]—This paper represents a considerable amount of work on the part of Alcoa Research Laboratories personnel and it is a real contribution toward the understanding of that unfortunately still foggy area of the effects of discontinuities on the performance characteristics of aluminum. The department of metallurgical research at Kaiser Aluminum Corp. has also developed experimental data which tell a similar story, namely, when discontinuities appear at the surface of specimens, the fatigue life is adversely affected.

I should like to ask two questions. First, were the discontinuities which were observed on the fractures of the fatigue specimens associated with definite ultrasonic indications?

The second question concerns the statement that a considerable amount of the specimens included in the test contained ultrasonic indications which were equivalent to 98 to 121 per cent of the indication from a No. 5 test block, whereas, in the table of data which lists the actual measured size of the revealed defect, there appears only one discontinuity with a measured area larger than a $\frac{5}{64}$-in. diameter flat-bottomed hole. Normally, we expect that the discontinuity will always be larger than the equivalent flat-bottomed hole response which we obtained from the reference block. Could this observation be interpreted as further evidence that the location of discontinuities with respect to part design is much more significant than the size of the discontinuity?

Mr. W. L. Fink (*author*).—In answer to the first question, the specimens taken from the less sound region of the forging were cut so that the discontinuities observed ultrasonically would lie in the minimum section of the specimens. Consequently, the discontinuities in location I of these specimens were in the fracture and, of course, associated with definite ultrasonic indications. However, when the ultrasonically observed discontinuity was not in location I, it did not nucleate fatigue failure and was not in general in the fracture. In fact, specimens Nos. 6 and 9 broke at the other end of the specimen.

The specimens cut from the sounder region contained only those discontinuities contributing to the hash. The discontinuities were so numerous that by chance all but one of these specimens contained discontinuities in the fractures. The ultrasonic indications associated with these discontinuities were, of course, lost among the indications from all the other discontinuities. That is, they were simply a part of the hash.

In reply to the second question, one does expect that a discontinuity will always be larger in area than the area of the flat-bottomed hole of the corresponding reference block. This was always the case in this investigation. Sometimes the area was much larger. However, discontinuities that were placed in location I (as were all of those at the bottom of Table I for which the size is given) were partly machined away in the preparation of the specimen so that the size of the discontinuity observed in the fracture is less than the size of the original discontinuity which produced the pip observed in the ultrasonic inspection. The discontinuity size used in the interpretation of these results was the size measured on the fracture. There was no correlation between the size of the discontinuity and the fatigue life.

Mr. Fred W. DeMoney.[2]—This paper is an interesting contribution in a field difficult to work in because of

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the many experimental difficulties, including the unknowns associated with the sonic tests and the interpretation of these tests.

I have three questions regarding the paper:

1. I understand from the results that these discontinuities are of the oxide type. What is the effect of other discontinuities, such as chrome bearing segregate, on the axial loading and rotating beam type test results?

2. Were any surface defects observed in locations other than on the surface at the hole?

3. This is more of a suggestion than a question. Often it is impossible to observe discontinuities on the fracture surface of the fractured specimen; if they are very small, they have either fallen out or are not easily observable. Therefore, it might be desirable to compare these results with the *S-N* curves of unnotched specimens prepared from sonically sound material.

MR. FINK.—In answer to the first question, the type of discontinuity involved in this test was the so-called "unhealed porosity"—evidently from pores that existed in the original ingot. There is, of course, some discoloration, a film of oxide on the surface of the pore. We did not have, in this particular series of tests, any segregate, or refractory inclusion, or anything of that sort. I might say that segregation is rather difficult to find ultrasonically. The segregation that is found usually consists of much larger particles than would be estimated on the basis of the reference block. Let us consider a piece of aluminum alloy containing chrome segregate that is not cracked, and makes good contact with the aluminum matrix. The amount of energy reflected from the aluminum-chromium interface is much less than the energy that would be reflected from a metal-air interface, because the density and elastic constants of these two phases do not differ enough to give a high percentage of sound reflection. If, however, the piece had been worked and this particle of chromium constituent had been shattered, the cracks across the chrome segregate would reflect nearly 100 per cent of the incident energy.

MR. IAN D. EATON.[3]—Some test results have been obtained on lugs taken from a sample of 7075-T6 hand forging in which no discontinuities were revealed by ultrasonic inspection. The fatigue strengths of the lugs taken in the short-transverse direction from this sound forging are in general slightly higher than those from the rejected forging. The fatigue strengths taken in the longitudinal and long-transverse directions are slightly lower for lugs from the sound forging than for lugs from the rejected forging. Thus, the directional fatigue properties for this sound forging are less pronounced than those shown in Fig. 9 for the rejected forging.

MR. JOHN A. FELLOWS.[4]—My problems deal with a somewhat different material, namely, uranium, and for a long time we have been interested in whether we could use test techniques of this sort, and we have always been bothered by problems arising from grain size. I wonder whether the author has done any work with cast aluminum where you might have encountered grain sizes of a magnitude that would have offered similar difficulties and at what size of grain this might have come about?

MR. FINK.—Yes, we regularly inspect aluminum ingots and, generally speaking, we have to use low frequencies to penetrate those ingots. Whereas we will examine wrought products at 10 Mc or, if the material is thin, 15 Mc, we find that it is necessary to use $2\frac{1}{4}$ Mc for ingots or even 1 Mc for certain types of ingots.

We had an interesting experience a number of years ago with grain size. We had a piece of heavy rod that we could not penetrate at the frequency we were using for the test. We attributed this difficulty to the fact that the wavelength of the ultrasonic signal was of the same order of magnitude as the grain size of the specimen because we could penetrate the specimen at either a higher of a lower frequency.

MR. W. S. PETERSON.[5]—Reference was made to unhealed porosity. Has the author observed healed porosity and are the properties of material containing healed porosity the same as properties of fabricated material made from original sound starting stock?

MR. FINK.—We have not seen anything on a microsection that we could identify as porosity that has been healed, but we have worked porous material using substantial reductions and obtained a final product with no discontinuities, or many fewer discontinuities than would be expected from the porosity in the original ingot. In other words, I am convinced that it is possible to weld together many of the pores that exist in ingots.

MR. PETERSON.—But the question is, have you ever tested material from starting stock which had porosity and was then supposedly welded together? Do you know if the properties of that material are as high as properties of material made from originally sound stock?

MR. FINK.—We have made tension tests on such material and got normal properties. I cannot answer the question in regard to fatigue tests.

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[3] Research engineer, Alcoa Research Labs., New Kensington, Pa.

[4] Manager, Metallurgical Development Dept., Mallinckrodt Chemical Works, St. Charles, Mo.

[5] Manager, aluminum research, Metallurgical Research Div., Olin Mathieson Chemical Corp., New Haven, Conn.

Instrumentation and Method for

Impulse Testing of Reinforced-Concrete Beams*

By F. T. MAVIS and M. J. GREAVES

The measurement apparatus which superimposes oscilloscope records and highspeed motion pictures without time parallax reliably recorded much data in a few milliseconds

The Problem

The problem which gave rise to the instrumentation and method presented in this paper involved a comparative study of the behavior under impulse loads of pairs of reinforced-concrete beams which were in all respects alike except for grade of reinforcement. Prior "pair-wise" testing of beams at Carnegie Institute of Technology was done in a machine that could test two beams at the same time by forcing their centers apart—the ends of the beams being tied together. The energy to apply the loads was stored in a pair of flywheels. During a test the beams were forced through a fixed displacement pattern. A typical load-time and load-deflection curve for this machine is shown in Fig. 1. While tests in this first machine achieved the main objective of an earlier study,[1] namely to determine whether beams with one grade of reinforcement would consistently fail or not fail, more intimate details were needed to show time-variations of load, reaction, deflection and other pertinent information. New instrumentation and methods were then developed for impulse testing of reinforced-concrete beams.

The testing machine hereafter described applied loads up to 9000 lb "instantaneously" by transfer from one closed system which included a loaded spring and trigger mechanism to another closed system which included the yoked beams. The transfer of load was accomplished by cutting a notched bolt which initially linked the two systems. The resulting load-time curves were similar to those produced by a blast. The deflection pattern was not fixed. Fluctuations of load and reaction, as measured by strain links, could be detected at intervals as short as 0.03 millisecond. Deflection and angle charge, as well as crack formation, could be observed clearly at intervals of about 1 millisecond.

Apparatus for Loading

Figure 2 shows the testing machine assembled and Fig. 3 shows a sketch of its components. The machine consisted of a driving spring which applied its load through plungers to vertical needle beams as shown in Fig. 2. The needle beams were tied together at the bottom by a tie-bar. The force in the spring was held in equilibrium initially by the closed system of needle beams, tie bar, load bar, load yokes and notched links. The spring was loaded by means of a hydraulic jack which is shown at the lower left in Fig. 2.

The test beams were held in a horizontal plane by stirrup-like beam supports and rods. A guide frame of angles with a separating diaphragm was bolted loosely around the two beams to keep them from twisting during a test. The beams were brought up snug against the bearings of the load and reaction yokes to form a second closed system. The load on the beams was usually a nominal 1000 lb before the notched bolt was cut.

Each reaction yoke consisted of two pipes connected by threaded rods. The two pipes which applied the reaction to one beam were connected by a rectangular bent of $\frac{3}{4}$-in pipe. At diagonally opposite corners of the two pipe bents were turnbuckles (as shown in Fig. 2, center right) to support a rectangular frame of reference in fixed position relative to the reaction points of the test

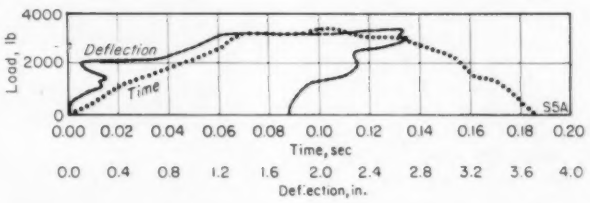

Fig. 1.—Typical load-time and load-deflection curves for beams tested in earlier fixed-displacement machine.

F. T. MAVIS, is professor and head of the Department of Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Penna., since 1944 has published extensively in hydraulic engineering, structural analysis, and applied mechanics.

MELVIN J. GREAVES, development engineer, Arthur G. McKee and Co., Cleveland, Ohio, submitted the thesis from which this paper was excerpted to the Department of Civil Engineering, Carnegie Institute, in partial fulfillment of the requirements for the degree Doctor of Philosophy.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the Sixtieth Annual Meeting of the Society, June 16-21, 1957.

[1] F. T. Mavis and F. A. Richards, "Impulse Testing of Concrete Beams," *Journal*, Am. Concrete Inst., Vol. 27, pp. 93-102 (1955).

beams (see also Fig. 4). The relative displacement between black lines stenciled on the beams and this frame of reference was measured in enlargements of the motion picture film to determine deflections as functions of time during a test.

The transfer of load to the test beams from the closed system of driving spring, tie bar, needle beams, and load bars was accomplished by cutting a notched bolt with a bolt cutter which is shown in Fig. 2. Transfer of load was "instantaneous" when the bolt was cut. A few milliseconds later the significant data had been recorded automatically by the measuring apparatus..

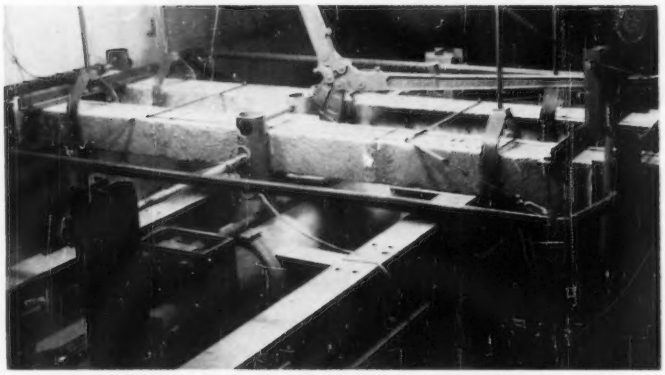

Fig. 2.—Spring-loaded impulse testing machine.

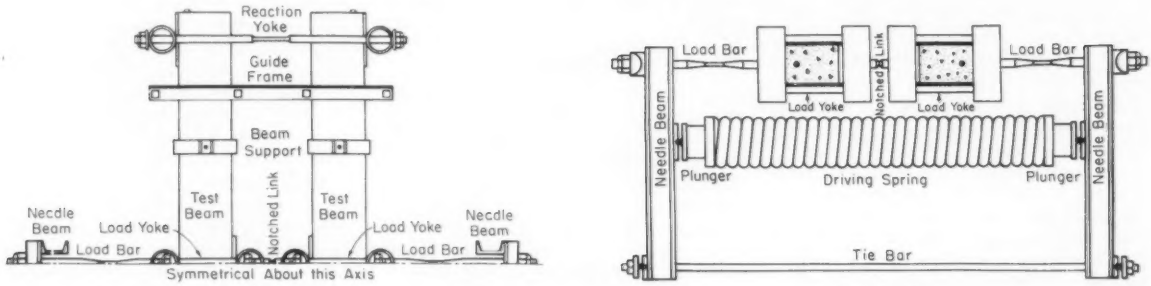

Fig. 3.—Diagram of spring-loaded testing machine.

Apparatus for Measurement

An Eastman high-speed motion picture camera was mounted 25 ft above the test beams with its front lens pointing down. During a test the camera photographs the beams at about 1.0 millisecond intervals through a rotating optical flat behind the front lens which effectively stops the image during an exposure time of 0.2 millisecond. The camera records through the back of the film by means of a side lens and mirror the fluctuations of points of light as picked up by cathode ray oscilloscopes during that millisecond interval. These oscilloscope traces appear as streaks superimposed on the photographs. Photographs are sharp and discrete; strain traces are sharp and continuous.

The optical diagram is shown in Fig. 5. To record load and reaction as indicated by strains in the load bar and reaction bar, two oscilloscopes were brought into focus on the back of the film by means of the side lens. The trace of one oscilloscope was reflected by means of a front-surface mirror as indicated in Fig. 5.

Circuits for measuring load and reaction are shown in Fig. 6. Four SR-4 strain gages were mounted in diametrically opposite pairs parallel to the axis of the bar, and four gages were wrapped around each bar, also in diametrically opposite pairs. This arrangement made the bars insensitive to bending and took advantage of the lateral contraction of the aluminum as it was pulled longitudinally. All bars were carefully calibrated before and after each use.

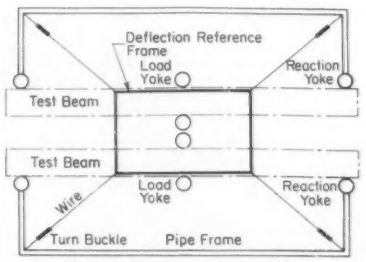

Fig. 4.—Deflection reference frame.

In some exploratory tests, a biaxial oscilloscope was photographed at 64 frames per second with another camera. Data obtained from two frames of motion pictures of a typical test are shown in Fig. 7. Loads are shown as abscissas and reactions as ordinates. The curve begins at the lower right—at a load of 6.5 kips[2] and a reaction of 1.0 kips. The horizontal portion of the curve indicates that the load dropped to about 5.0 kips before there was any change in reaction. Thereafter the load and reaction varied as shown by the tangled curve until the beams came to rest with both load and reaction equal to 3.8 kips—at the upper end of the dotted line. The dotted curve, down and to the left, is the static unloading curve as the spring was unloaded slowly after the test.

The tangled curve in Fig. 7 is typical of "signatures" that were traced by other pairs of beams. For similar beams, these signatures were as much alike as one might duplicate his own signature.

Two observations can be made from the curve of Fig. 7: (1) the magnitudes of both load and reaction in the dynamic test reached maximums which were nearly double those which would have caused the weaker beam to fail; (2) whereas load and reaction are always equal in a static test, they are never equal in the dynamic test except when the tangled curve crosses the extension of the straight dotted diagonal line.

While a motion picture camera operating at 64 frames per second recorded useful data from a biaxial oscilloscope, it was replaced by the more versatile high-speed motion picture camera which superimposed two oscilloscope traces on photographs taken at a rate of about 1000 frames per second. With the latter instrumentation, both the time record of technical data and the picture record of events could be studied in detail after the test.

[2] kips = 1000 lb.

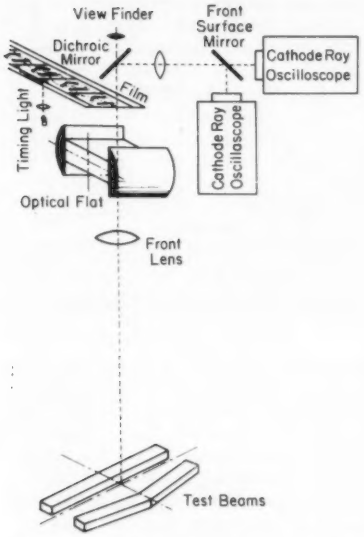

Fig. 5.—Optical diagram for high-speed camera.

Time scales were traced on the high-speed motion picture film in two ways: (1) by means of an argon light built into the camera which marked the edges of the film sharply at intervals of $^1/_{120}$ sec; (2) by means of a modulated trace on the oscilloscopes, usually flashing 7500 times per second.

Pictures from a typical high-speed camera record are shown in Fig. 8. The right dotted trace in Fig. 8 shows load, and the left dotted trace shows reaction—both as functions of a common time scale running lengthwise of the film. The faint continuous trace near the left is a line of reference for the oscilloscope records. Data from these pictures as projected to a large scale are analyzed in the next section.

The oscilloscopes that were photographed through the side lens of the high-speed camera had acceleration potentials of 3000 v and short-persistency tubes (Dumont 304-A oscilloscopes with P-11 tubes).

Twelve reflector photofloods RFL2 lighted the concrete beams during a test. They were arranged along two lines about 2 ft above the beams and 2 ft on each side of a vertical plane midway between them. They provided roughly 2500 foot-candles incident light on the beams.

Four kinds of high-speed motion picture films were tested. All recorded excellent images through the front lens, but only one (Dupont 931-A) simultaneously showed usable traces of oscilloscope records through the side lens. It is not certain whether this was due to different characteristics of the anhalation backing of the films or to something else. In these film tests, the aperture

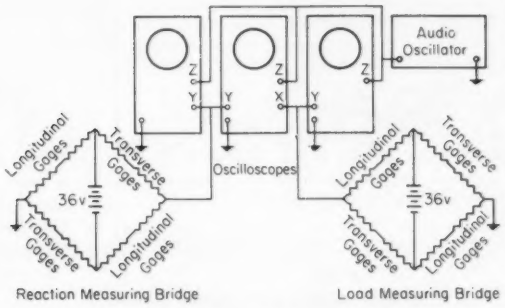

Fig. 6.—Load and reaction measuring circuits.

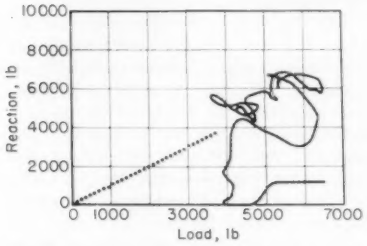

Fig. 7.—Data from typical motion picture of load-reaction record on biaxial oscilloscope.

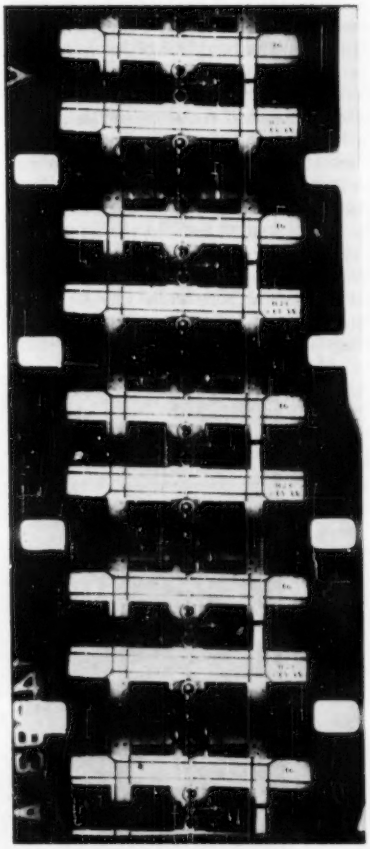

Fig. 8.—Picture from a typical high-speed motion picture record.

was f/2.0 for the side lens and usually f/2.7 for the front lens. With exposure times about 0.0002 sec this corresponded to film speed ratings of ASA-400 and higher as the films were processed.

Films were bought in commercial 100-ft rolls, not specially spooled for high-speed cameras. Even so, chipping of the ends of the film was rare indeed. The films were usually processed "rapid reversal" according to the manufacturer's recommendations. However, films that were developed as negatives in a rewind tank showed fine detail for technical study.

After the beams were in position and the camera, oscilloscopes and lighting had been checked, the procedure during a test was about as follows:

1. The bolt cutter was placed over the notched link and the jaws were closed down to bite the link firmly.
2. The load spring was compressed by hydraulic jacks. The nuts on the load bars were drawn up snug. The jacks were released, tranferring the load to the notched link. The final spring setting was measured and recorded.
3. The reaction yokes were adjusted to an initial midspan load of about 1000 lb. Load and reactions were read on the oscilloscopes and recorded.
4. Floodlights were turned on and the intensity on the oscilloscopes was turned up.
5. In cadence with a pendulum, the count of seconds began: 10-9-8-7 . . . The bolt cutter power was turned on at the count of 5; and the high-speed camera was started at the count of 0. The beam broke about 1 to 2 sec after the count of 0.
6. The final spring position, residual load, reaction (if any) and beam deflections were recorded. Still photographs were taken to complete the test record.

The authors fortunately did not "lose" a single test by failing to record usable data. It was difficult for two people, hidden from one another during a test, to synchronize their operations within about one second's leeway—which was about the maximum toler-

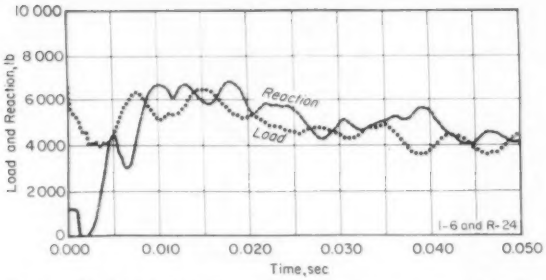

Fig. 9.—Typical load-time and reaction-time curves (6.5 kips test).

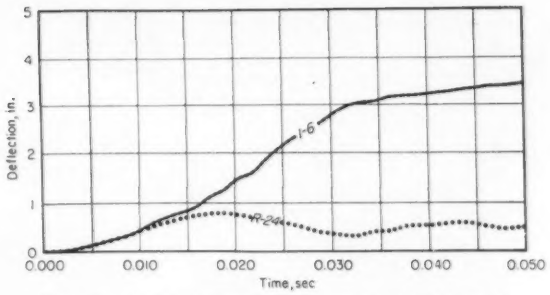

Fig. 10.—Typical deflection-time curves (6.5 kips test).

ance involving inter-communication and reaction time. Every test was productive and contributed to the over-all pattern of technical data—but there were several tense near-misses.

Typical Data and Their Analyses

The raw data as recorded by the high-speed camera were projected onto sheets of drawing paper frame-by-frame by a highly corrected projector. Each motion picture frame (7.5 mm) was enlarged to a full 36 in. Thus one 50 yd roll of drawing paper was used to analyze what happened in the first 50 milliseconds of each test. Projected to this enlarged scale there was superimposed on instantaneous photographs taken at millisecond intervals an oscillograph record which was continuous at a rate (in the enlarged projection) of 3000 ft per sec. By studying each projected photograph carefully, there was analyzed from the high-speed motion picture record:

1. Load and reaction as functions of time measured from the clearly defined instant the load was applied (see Fig. 9 for a typical curve).
2. Midspan deflection of each beam as a function of time (see Fig. 10).
3. Angular deflection and angular velocity (measured between end tangents) as a function of time.
4. The propagation of cracks in the beams during the test.

Figure 9 shows, for example, how reaction initially lags load by about 1 millisecond in this test, and after dropping to zero at about 2 milliseconds, the reaction rises to 6.5 kips (the initial load) in three waves which peak at 10, 13 and 18 milliseconds.

The times at which the load and reaction are equal, as shown in Fig. 9 where the curves cross one another, have meaning in the final analysis of data, since at these instants the beams are moving at constant speed.

Data recorded on the high-speed motion picture film were clear and there were means of cross-checking all important data. No less than 2500 independent observations of basic data were collected in a 50 millisecond interval.

The typical deflection-time curves (Fig. 10) and angular deflection-time curves are relatively smooth as might be expected. The load-time and reaction-time curves (Fig. 9) show individual fluctuations—again as might be expected. The curves are consistent one with another as verified mathematically by obvious methods not detailed in this paper.

The raw data for each impulse test of two reinforced-concrete beams involved force (load and reaction), displacement of each beam, and time. Data were available from each test for a detailed study of the behavior of each pair of beams by applying principles of impulse-momentum or work-energy—a study which is beyond the scope of this paper.

However, interest in energy-absorbing capacity of reinforced-concrete members in bomb shelters is keen, and the following brief notes on the comparative behavior of beams tested in the authors' apparatus may be appropriate. Beams were tested in pairs at spring-energy levels ranging from 30 in. kips to 60 in. kips—corresponding to initial spring loads of 6.5 kips to 9 kips. When 40 in. kips was suddenly released by the machine during a test, the intermediate-grade beam always failed while the hard-grade beam remained intact. A typical view is shown in Fig. 11. Moreover, at that spring-energy level a hard-grade beam never failed, whether it was paired in an impulse test with an intermediate-grade beam, with another hard-grade beam, or with a structural steel beam of equal weight but greater strength and stiffness.

The two beams in Fig. 11 were identical except that the broken beam was reinforced with an intermediate-grade bar and the unbroken beam with a hard-grade bar.

Summary and Conclusions

The apparatus for measurement superimposes oscilloscope records and high-speed motion pictures without time parallax. It was effective and reliable in recording a large quantity of data in a few milliseconds. Moreover it provided data which could be studied repeatedly at leisure afterward. There are many opportunities to check one observation against another either directly or by recourse to differentiation or

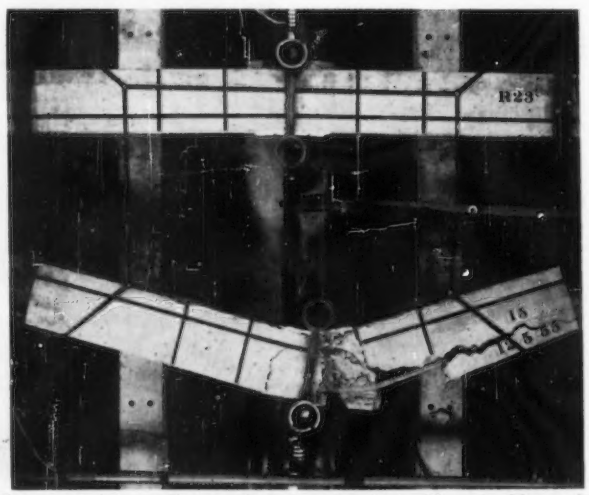

Fig. 11.—Damage to intermediate-grade beam after test with 40 in. kips spring energy. (Hard-grade beam intact).

integration consistent with geometry and the principles of mechanics.

The apparatus for loading was adequate for the beams studied. It can be modified to provide greater or lesser loading capacities and, within physical limitations of materials, to longer and shorter durations of loading. A wide variety of impulse characteristics (force as function of time) can be designed into such a spring loading system.

The apparatus and procedures need not be limited to motion pictures taken with one camera. With mirrors or two high-speed motion cameras it is possible to study triaxial movements in a limited space by stereographic methods.

The examples of tests reported in this paper are intended primarily to show how the instrumentation and method were applied in a larger investigation of the behavior of reinforced-concrete beams under impulse loads that simulate blast loadings. The examples are typical. When two laboratory beams that were identical except for grade of reinforcement were impulsively tested pairwise at an initial spring load of 7.5 kips and an energy level of 40 in. kips, the beam reinforced with intermediate-grade steel always failed while the beam reinforced with hard-grade steel never failed.

DISCUSSION

MR. WALTER H. PRICE.[1]—Were tests made at ordinary loadings that would be expected in a building, apart from impact loadings, and if so, how did the steels compare at slow rates of loading?

MR. M. J. GREAVES (*author*).—Tests were made on steel coupons, concrete cylinders, and reinforced-concrete beams at slow rates of loading in a universal testing machine for control purposes. Beams reinforced with intermediate grade bars had an average ultimate load capacity of 3600 lb. Similar beams reinforced with hard grade bars had an average ultimate load capacity of 6700 lb. The ratio of the average ultimate load capacities of the beams was 1 to 1.86. This corresponded closely to the ratio of the yield points of the steel coupons which was 1 to 1.88. These results suggest that the ultimate load capacities of the beams were related to the yield points of the reinforcing steels.

CHAIRMAN L. E. GREGG.[2]—Are you publishing any of the data on slow tests?

MR. GREAVES.—A summary of the data is being published in another paper[3] which does not deal with the instrumentation methods.

MR. GLENWAY MAXON.[4]—Would a prestressed beam be even stronger in resisting deflection than the extra-strong reinforced-concrete beam, or were they comparable as far as breaking energy is concerned?

MR. GREAVES.—We did not test any prestressed concrete. However, in all of these tests we loaded the beams to about three-fourths of their design strength prior to the application of the simulated blast load.

MR. MAXON.–Both beams had the same design strength?

MR. GREAVES.–Both beams had the same design strength, because they had the same dimensions, the same concrete mix, the same size reinforcing bars, and current design practice generally allows the same design stress for intermediate grade as for hard grade steel.

MR. PERRY PETERSEN.[5]–What was the significance of the 3 per cent elongation? Is that a maximum or would you require that much in order to keep below the point at which the beam shatters?

MR. GREAVES.–During the course of analyzing the records made by the high-speed camera, the position of the reinforcing steel was located by a line drawn on a full size projection of each motion picture frame. Reference points were established along these lines and located by measurement on each projected image. The elongation between pairs of reference points was figured by taking the total change in distance between pairs of reference points and dividing it by the initial distance between these points. Whenever the elongation reached about 0.03, cracks appeared and the beams rapidly disintegrated.

MR. PETERSEN.–Then I can assume that the steel of the intermediate grade was stressed beyond the 3 per cent at its yield point—that is, much before the other was even stressed up to its yield point.

MR. GREAVES.–In each of the pairwise tests, the elongation exceeded 3 per cent as measured on the projected images of the beam which subsequently failed. The elongation along the beam that did not fail did not reach 3 per cent.

After each test, the bars were removed from the beams and the residual strain distribution was determined by measurement. The maximum residual strain in the intermediate grade steel bars averaged about 0.05 in a 2-in. gage length, or about 13 per cent of the limiting static strain, as measured in control tests of steel coupons. No residual strain could be detected in the hard grade bars which were paired against intermediate grade bars. When hard grade reinforced-concrete beams were paired against a welded steel beam and when sufficient energy was applied to break the reinforced-concrete beam, the maximum residual strain of the reinforcing steel was about 0.01 or about 6 per cent of the limiting static strain as measured in control tests of steel coupons.

MR. BRYANT MATHER.[6]–Do you know whether experiments have been conducted in which similar instrumentation has been employed in tests using actual explosive loading—particularly, have the high-speed motion picture camera and the oscilloscope technique been used to record actual blast effects on concrete members? Would the technique be applicable?

MR. GREAVES.–I do not know of any other case where the high-speed camera-oscilloscope technique has been used to record actual blast effects on reinforced-concrete beams. The technique should be readily adaptable, and such tests offer a fertile field for investigation.

MR. A. CARL WEBER.[7]–Were there any tests to follow through on the question that was asked about the unbalance of the two sections? Was there an attempt made to equalize by increased steel area and increased section an equivalent reaction that would be developed by this so-called harder reinforced section? I realize the inertia of the two test pieces might vary, but was that attempted?

MR. GREAVES.–That was not attempted in a pairwise test because in all of our pairwise tests, the two beams had identical weights. However, Mr. Stewart conducted some tests with a wider range of steel percentages. He may wish to add something.

MR. J. J. STEWART.[8]–I have tested concrete beams with different grades and percentages of reinforcing steel under identical impulsive loads. The beams were tested one at a time instead of pairwise. Because I have not completed the analysis of the data, I prefer not to draw any conclusions now.

MR. WEBER.–I recall a paper in which two beams with lower strength steel were compared with one of harder steel but with added weight to create equal inertia condition. This beam withstood the two others. In your final setup did you obtain any results on an arrangement which would approximate an unbalanced design of reaction?

MR. GREAVES.–You are referring to the earlier study by Mavis and Richards. No tests of this nature were made on the equipment described in this paper.

[1] Head, Engineering Laboratories, U. S. Bureau of Reclamation, Denver, Colo.
[2] L. E. Gregg and Associates, consulting engineers, Lexington, Ky.
[3] F. T. Mavis and M. J. Greaves, "Destructive Impulse Loading of Reinforced Concrete Beams," *Journal*, Am. Concrete Inst., Vol. 29, pp. 233–252 (1957).
[4] Consulting engineer, Milwaukee, Wis.
[5] Director of engineering, The Master Builders Co., Cleveland, Ohio.
[6] Engineer (Concrete Research), Corps of Engineers, Concrete Div., Waterways Experiment Station, Jackson, Miss.
[7] Director of research and engineering, Laclede Steel Co., St. Louis, Mo.
[8] Assistant professor, Department of Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

A Reactive Aggregate Undetected by ASTM Tests *

By E. G. SWENSON

In Canada, an unusual case of cement-aggregate reaction for which the standard tests were not effective

ABNORMAL expansion and map-cracking of concrete has occurred at Kingston, Ont., mainly in structures such as sidewalks, curbs, floors, and foundation walls. The problem was brought to the attention of the Division of Building Research by a large Government construction agency and an investigation was begun in 1955.

Preliminary laboratory tests established that an argillaceous dolomitic limestone coarse aggregate was a responsible factor. The characteristic cracking pattern and the conditions under which excessive expansion had occurred suggested that a cement-aggregate reaction was involved. Accordingly, the ASTM tests for such reactions were carried out and samples of the aggregates and the affected concretes were examined petrographically by a recognized authority in this field.

At the same time, extensive tests were carried out on actual concrete specimens. There were two reasons for taking this step: The apparent absence of some of the usual symptoms of cement-aggregate reaction, such as reaction rims and gel exudations, made it necessary to consider other factors such as freezing and thawing. Secondly, the urgency of the field situation made it necessary to try out possible remedial measures early in the investigation.

Although further research will be required to establish the exact nature of the problem and to provide a final practical solution, the results to date are believed to be of unusual significance and warrant the unusual step of making preliminary information available at this time.

In brief, the phenomenon which has occurred in this case appears to be a type of cement-aggregate reaction which is not revealed by recognized ASTM tests and which evidently lies outside the experience of more than one recognized authority in this field.

General Aspects of the Problem

One of the most severe field cases, where the sources of materials, the mix design, and other data were available,

Fig. 1.—Map cracking in sidewalk, showing extruded joint filler due to expansion of concrete.

was selected for study. This was a sidewalk, a section of which is shown in Fig. 1. Excessive expansion had closed the joints, and cracking had occurred within six months of placing. The cracks defined roughly hexagonal areas about 2 to 3 in. across and extended deeply into the concrete, being clearly distinguishable from surface "crazing."

Samples of crushed limestone coarse aggregate, sand, and cement were obtained from the original sources and concrete prisms were made, using the same mix proportions that had been used for the job. The prisms were kept in a curing room continuously and measured periodically for length change. Control prisms were made with laboratory reference materials using the same mix proportions. Figure 2 shows the record of expansion of the test specimens, in which cracks became clearly visible at about 0.10 per cent expansion.

A similar test was carried out using the same materials but with combinations of the local limestone crushed aggregate with a reference sand and a reference limestone crushed aggregate with the local sand. The results of the tests produced data similar to those in Fig. 2 and showed that the local crushed limestone coarse aggregate was responsible for the abnormal expansion of the concrete and that the sand component apparently did not play a significant role, at least in the extremely rapid expansion occurring in the first 12 months.

Petrographic examination of specimens of both laboratory and field concretes which had expanded excessively revealed unmistakable evidence of cement-aggregate reaction involving the crushed limestone particles, many of which exhibited darkened reaction rims. The exact nature of the reaction and the constituent actually responsible were not detected. The absence of significant amounts of gel deposits was considered significant. Petrographic examination of the dolomitic limestone revealed that the constituents could be regarded as not normally reactive with high-alkali cements. Physically this material was considered satisfactory. It was found that about 2 per cent of the sand consisted of materials known to be reactive with high-alkali cements. This quantity was not regarded as evidence that the sand as a whole was deleteriously reactive.

A survey of concrete work exhibiting the characteristic map-cracking in the affected area indicated that this problem has occurred principally under conditions of dampness or wetting and drying, and included elements protected from the weather as well as exposed sections. Since the large cracks extended most of the distance through the elements examined, it appeared that a differential movement had occurred in such a way that the inner part expanded at a relatively uniform rate under a continuously moist environment, while the expansion in the outer part had been

E. G. SWENSON, associate research officer, Materials Section, Division of Building Research, National Research Council of Canada, former assistant professor in chemistry at the University of Saskachewan, is currently in charge of cement and concrete research and the author of several papers in this field.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the Sixtieth Annual Meeting of the Society, June 16–21, 1957.

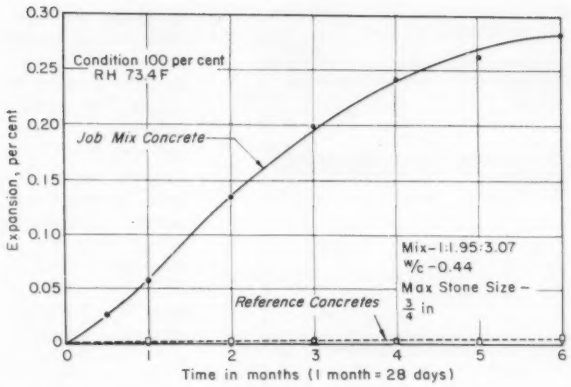

Fig. 2.—Length change of concrete prisms under continuous moist storage.

interrupted by periods of drying, thus leading to progressive deepening of the cracks which had begun at the exposed side.

The field survey revealed that this problem has existed to some degree for many years in this area. Limited but reliable records have established that the particular limestone quarry which supplied the coarse aggregate for the cases investigated has not been the only source of aggregates for concretes which have subsequently developed map-cracking.

Materials Selected for Study

The limestone coarse aggregates and the sands used in the main laboratory study are designated and described in Table I. The limestone samples KA, KB, KC and KG were all from the quarry which had been the source of limestone used on the jobs which gave rise to the original inquiries. The KG sample was from a 6-ft "greenish" stratum at about the 24- to 30-ft level in the quarry which was reported to be excluded from the stone used for concrete, due to its inferior quality. The absorption of this material was about 3 per cent as compared with about 0.7 per cent for the other samples. The OC reference limestone and AS reference sand have both had satisfactory performance records and were used in control specimens for purposes of comparison.

TABLE I.—AGGREGATES USED IN TESTS.

Designation	Description
	Limestones
KA.....	Crusher-run, used in preliminary tests
KB.....	Rock samples, laboratory crushed
KC.....	Crusher-run
KG.....	24- to 30-ft "greenish" layer
OC.....	Reference, outside source
	Sands
CS.....	Land-mined; used on job
LS.....	Lake sand; locally used
AS.....	Reference, unreactive
RR.....	Alkali-reactive reference
KR.....	Conrow-reactive reference

TABLE II.—ALKALI CONTENTS OF CEMENTS USED IN TESTS.

Designation	Source	Alkali Content, per cent		
		Na_2O	K_2O	Total as Na_2O
B.....	East Canada	0.56	0.96	1.19
M.....	East Canada	0.52	0.80	1.05
E.....	West Canada	0.09	0.54	0.45
UH...	U.S.	0.96	0.05	0.99
UM...	U.S.	0.46	0.09	0.52
UL...	U.S.	0.01	0.14	0.10

TABLE III.—DATA FROM QUICK CHEMICAL TEST FOR POTENTIAL ALKALI-REACTIVITY.

Aggregate	S_c, millimoles per liter	R_c, millimoles per liter
KB.....	19.1	160.3
KG.....	8.3	323.3
OC.....	6.5	48.6
CS.....	10.4	53.6
AS.....	9.7	70.3
RR.....	98.3	63.1

Alkali contents of the normal portland cements used in these studies are given in Table II. Cement B was obtained from the principal source of supply for the affected area.

Tests for Cement-Aggregate Reaction

Chemical Test

The results of the Quick chemical test, ASTM Method C 289 – 54 T,[1] for the KB and KG limestones, the local CS sand, and for selected reference materials are given in Table III. The data indicate that these local materials are not deleteriously reactive to high-alkali cement. Reference to experiences with the Quick chemical method show, however, that a dolomitic limestone can effect an extraneous reduction in alkalinity and, in some cases, may also give a fictitiously low silica release (**1,2**).[2] In view of the results of later tests with concrete prisms, which showed that the expansive reaction produced by the limestone coarse aggregate was influenced markedly by the alkali content of the cement, the R_c and S_c values for this material cannot be accepted as reliable.

It has been suggested that, for cases of this kind, the test may be performed on the acid insoluble fraction, but this procedure may yield spurious values for silica release (**2**). Work in this direction is in progress.

Mortar Bar Test

The standard procedure for this test (ASTM Method C 227 – 52 T),[3] was followed except that duplicate 5-in. bars were used. Various combinations of aggregates, cements, and pozzolans were tested, and some typical data are shown in Fig. 3. A representative sample of the limestone, KB, showed more than normal expansion with the high-alkali cements but not sufficient to be classified as deleteriously alkali-reactive. Expansion was markedly reduced with the use of a low-alkali cement or by replacing 25 per cent of the cement with a California calcined shale. The apparent nonreactivity of the highly absorptive KG material (24–30 ft layer) was consistent with later results for the concrete beams tests. The CS sand used in the field case was shown to be nonreactive in this test.

The failure of the mortar bar test to reveal deleterious alkali reactivity in the limestone in question, despite the influence of cement alkalis later shown in the concrete prism tests, may be due to one of several possible factors (**4**), among them the possibility that more than one type of reaction is involved. A study of this and other aspects of this case is contemplated.

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[1] Tentative Method of Test for Potential Reactivity of Aggregates (Chemical Method) (C 289 – 54 T) 1955 Book of ASTM Standards, Part 3, p. 1206.

B and M—two high-alkali cements
R—low-alkali cement
KB—sample of the reactive limestone
KG—highly absorptive greenish layer
CS—local land-mined sand
RR—alkali-reactive reference sand
OC—unreactive reference limestone
The pozzolan is California calcined shale.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

[3] Tentative Method of Test for Potential Alkali Reactivity of Cement-Aggregate Combinations (C 227 – 52 T), 1955 Book of ASTM Standards, Part 3, p. 47.

B—cement, KB—limestone, and CS—sand are combinations commonly used in affected area
OC—limestone and AS—sand are unreactive reference materials

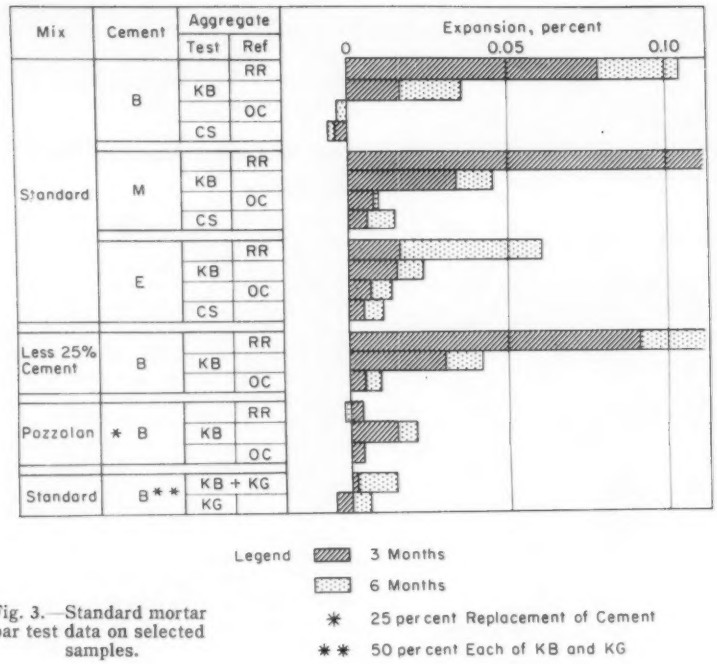

Fig. 3.—Standard mortar bar test data on selected samples.

Conrow Test

In this test (ASTM Method C 342 – 55 T),[4] mortar bars made with the KB and KG limestones and the CS sand gave negative results with the B and E cements. The CS sand in combination with the M cement produced an expansion of the bars approaching the 0.2 per cent limit at 12 months. On the basis of other tests with concrete beams, it was concluded, however, that the CS sand did not contribute significantly to the rapid rate and high degree of expansion observed for the concretes, at least in the first year. The apparent unsoundness of the CS sand cannot be ignored, however, as a possible contribution to later stages of deterioration of concretes in the affected area.

Tests with Concrete Prisms

Influence of Exposure Conditions

Concrete beams were subjected to certain exposures to determine those conditions which promoted the abnormal expansion observed in the field cases. The most pertinent conditions were:

(*a*) Continuous exposure to 100 per cent relative humidity and 73.4 F;

(*b*) Outside exposure to weather, beginning in early summer;

(*c*) Freezing-and-thawing cycling consisting of 6 hr freezing to 10 F and 6 hr thawing at room temperature (56 cycles in 28 days); and

(*d*) Wetting-drying cycling; 6 hr wetting at room temperature and 6 hr drying at 130 ± 3 F; this was a modification of the Scholer method (**3**) and currently under study in this laboratory (56 cycles in 28 days).

For the mixes used in this series, the sands were separated into six fractions and reblended to conform to ASTM grading requirements. Equal parts of $\frac{1}{4}$ to $\frac{3}{8}$ in. and $\frac{3}{8}$ to $\frac{1}{2}$ in. stone sizes were used. All aggregates were in a laboratory-dry state when incorporated in the concrete. The beams were 3 by 4 by 16 in., with measuring studs countersunk at each end. Measurement of length was made to the nearest 0.0001 in. with a special comparator.

Figure 4 shows a set of curves typical of several series of tests carried out simultaneously. The mix in this case was $1:2\frac{1}{4}:2\frac{3}{4}$, water cement ratio = 0.47, entrained air = 5 ± per cent, and slump 2 in. The B-KB-CS (cement-stone-sand), prisms made with materials from sources used on the job investigated, are shown to expand excessively under all four conditions. Since the reference concretes, B-OC-AS, showed no significant volume change under any of these conditions, only the data points for one condition are shown in Fig. 4. Abnormal expansions similar to those for the B-KB-CS samples shown were obtained for a B-KB-CS mix containing no entrained air, and a M-KB-CS mix with another high alkali cement, M, sometimes used in the affected area. Wetting-drying cycling and exposure to high humidities invariably produced greater expansions than freezing-thawing and outside exposure. Conditioning at 100 per cent relative humidity and 100 F produced more rapid initial expansion than any of the above methods of exposure. Expansions in the duplicate samples were in very close agreement until cracking began to be visible at about 0.08 per cent expansion. Beams made with the greenish KG limestone as coarse aggregate showed only a slight tendency to expand after 9 months of outside exposure. This is in agreement with the mortar bar test on this material. The presence of this material in varying amounts in the coarse aggregates used in field concrete may be a factor in the marked differences in the severity of this problem observed in the affected area.

The results of these exposure tests as well as evidence from field cases indicated that abnormal expansion occurred as a result of some internal reaction which was influenced primarily by moisture and temperature conditions.

Influence of Materials

It was found that the separate samplings of limestone, KA, KB, and KC, each considered to be representative of the stone used for concrete from this quarry, produced marked differences in degree of expansion, suggesting variability in the quarry material. Beams made with varying proportions of the highly absorptive KG and the KC limestone sample showed decreased expansion with increasing amounts of KG. These tests were carried out at 100 per cent relative humidity and 73.4 F. This property of the KG material was noted previously.

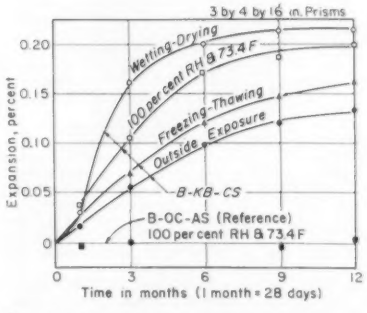

Fig. 4.—Effect of exposure conditions on degree of expansion of concrete prisms.

[4] Tentative Method of Test for Potential Volume Change of Cement-Aggregate Combinations (C 342 – 55 T), 1955 Book of ASTM Standards, Part 3, p. 1244.

B and UH—high-alkali cements
E, UM, and UL—low-alkali cements
KC—reactive limestone
OC—reference limestone
LS—local sand

Concrete beams made with the KC limestone sample and cements with varying alkali contents (Table II), and conditioned at 100 per cent relative humidity and 73.4 F, produced differences in expansion which indicated that the reaction of the limestone producing this expansion was sharply influenced by the alkali contents of the cements. Typical data are shown in Fig. 5. The reason for the difference in rate and degree of expansion between the concretes containing the two high-alkali cements B and UH, was not determined. The UH cement is the more finely ground, and it is to be noted also that the relative amounts of sodium and a potassium oxide present in each cement are markedly different (Table II).

A number of admixtures were used to determine their effectiveness in reducing abnormal expansion with the high-alkali cement B. A 25 per cent replacement of cement by weight with calcined shale was most effective. Fly ash was less effective, and it was found that the mere reduction of the cement content by 25 per cent with no addition reduced the expansion nearly as much as the fly ash. A finely divided, non-pozzolanic silt reduced the expansion by about the same amount. Addition of 1 per cent lithium chloride had about the same effect. These results, after 8 to 11 months, seemed to indicate that pozzolanic or chemical admixtures of the type usually found to be effective in controlling cement-aggregate reaction have less beneficial influence than usual in this case.

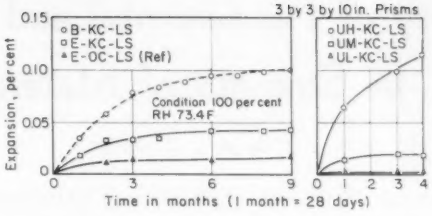

Fig. 5.—Influence of alkali content of cements on expansion of concrete prisms.

Summary

In the course of a Canadian investigation, a dolomitic limestone coarse aggregate has been found that produces excessive expansion and cracking in concrete. This phenomenon was reproduced in the laboratory with concrete prisms subjected to highly humid conditions or to a wetting-and-drying test. Abnormal expansion was usually obtained in a few weeks. The rate and degree of expansion were found to increase with increasing alkali content of the cement. Pozzolans and chemical admixtures, which are usually effective in controlling alkali-aggregate reaction, showed somewhat limited beneficial influence in this case.

Despite the observed influence of cement alkalis, the results of the ASTM Test Method C 289 on the limestone were negative. The limitations of this test when applied to dolomitic limestones were, however, recognized. The results of the ASTM mortar bar test were also negative but indicated some alkali-reactivity in the limestone. The negative results of the ASTM Conrow test apparently eliminated the possibility of a cement-aggregate reaction of the type for which this method was developed. Expert petrographic evaluation, not given in detail here, indicated that some type of cement-aggregate reaction was involved but the exact nature of the reaction was not established. The constituents of the limestone were regarded as not normally deleteriously reactive with high-alkali cements.

This brief paper is intended to provide for the benefit of those concerned with the use of the standard tests for alkali-aggregate reaction a record of this Canadian experience with an apparently unusual case of cement-aggregate reaction for which the standard tests were not effective. The prism test herein recorded can be commended in view of the assistance which it has given in the study of the case under review. Work is continuing on the problem, and more detailed reports on the case in question will be published in due course.

Acknowledgments:

The author wishes to record his appreciation of expert assistance received from the U. S. Bureau of Reclamation, W. H. Price, chief of laboratories, and especially for the help given by R. C. Mielenz and D. Ramaley of the Bureau's Petrographic Laboratory. Valuable assistance has also been given by other U. S. experts to whom the author's thanks are also recorded. Much assistance was naturally received from the staffs of the various Canadian agencies involved with the problem now under study and from many of those interested in the problem in the Kingston area. This paper is a contribution of the Division of Building Research of the National Research Council of Canada and is published with the approval of the director.

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DISCUSSION

MR. BRYANT MATHER[1].—I should like to compliment the author on a very excellent job of tying field performance with laboratory investigations. I believe that it is through studies of this sort that we can best learn the extent and scope of these problems.

I would say, however, that we have had some previous indications of cement-aggregate reaction apparently involving dolomitic limestone, particularly some cases in Southern and Central Indiana,[2] in Ohio, and in Virginia. All of these involved dolomitic limestone and natural sand. Unfortunately none of them have been investigated to the extent that the author has investigated the Kingston problem and therefore have not received much publicity or adequate documentation. I suspect that had they been more thoroughly investigated they would have proved rather similar to this Kingston situation. I hope that the author's presentation of these data will inspire people in the United States who have heard of these other cases to investigate them more thoroughly, and inspire others to pin down some of the poorly known cases of concrete deterioration that may provide still further examples.

[1] Corps of Engineers, Concrete Div., U. S. Waterways Experiment Station, Jackson, Miss.

[2] R. W. Gilmore, "Railway Concrete Deterioration," *Proceedings*, Am. Concrete Inst., Vol. 48, p. 731 (1952); Katharine Mather, "Crushed Limestone Aggregates for Concrete," *Transactions*, Am. Inst. Mining and Metallurgical Engrs., *Mining Engineering*, Oct. 1953, p. 1022.

On the Necessity of Fundamental and Widened Research In Strength of Materials

By M. V. ZAUSTIN

In the not too distant past, when factors of safety were quite large and the principal engineering material was steel, ordinary test data, such as nominal results of tension tests and a few other properties, were sufficient for satisfactory design. This situation has rapidly changed and a modern design engineer needs more refined, more accurate, and more specific data than ever before

NEW DESIGN REQUIREMENTS

WHAT are the changes and new conditions of design? They are: strict requirements of minimum weight and maximum strength; a great danger of failure in such applications as airplanes, pressure vessels, and high-speed machinery; structures involving repeated loading at high stresses, vibrational loadings, mechanical and thermal shocks; complicated stress combinations; extremely high or low operating temperatures; use of corrosive liquids and gases moving with cavitating speeds. Finally, we now have better quality materials with smaller scatter of test results and, consequently, an unexplored possibility of using smaller factors of safety.

All these features of modern engineering require not only higher accuracy of calculations but also more accurate and more suitable test data, to enable the design engineer to predict with confidence the behavior and strength of his designs.

The gap between the strength of parts in service and the strength of materials determined in laboratories can no longer be bridged by large factors of safety.

The Need for a New Branch of Materials Engineering

The fields of stresses and strength of materials must be brought closer together. What separates these two fields? In most cases the disagreement between the strength of the design elements and the strength of the specimens, made of the same material, is caused by the peculiar effect of the stress system (pattern) on the strength of materials. Regardless of whether a given stress combination is obvious, as in pressure vessels, or is hidden, as in cases of stress concentrations and residual stresses, its effect is always present. Finding the relationship between the strength of the design element in service and the strength of materials, measured in laboratories, should make a special branch of materials engineering which, when applied to metals, might be called Metal Mechanics.

Such study has little to do with the metallurgy which deals with the chemical and structural transformations of metals and alloys; nor much to do with the "strength of materials" which is essentially a science of transmission of forces. It is rather the child of the art and science of testing materials. Its sole purpose is the scientific determination of the allowable stresses, with the idea in mind of bringing the actual strength of the design elements into agreement with the laboratory strength of materials. This transition from the strength of specimens to the strength of structural elements is the greatest problem of modern experimental and theoretical strength of metals.

We have on the one hand the results of laboratory tests of materials in which a straight, smooth specimen is gradually loaded, the stress distribution is uniform, the temperature is constant. In short, the specimen is tested under standard laboratory conditions. On the other hand, we have a design element that is not straight, is not always smooth, has holes and cutouts; its stresses are not uniformly distributed and are not simple but combined; the load is suddenly increasing or decreasing, the temperature is changing, the surrounding medium is not neutral. Thus the operating conditions of a design member are entirely different from the test conditions of a specimen and the standard experimental data cannot necessarily be applied directly to a structural member. Certainly there are cases in which ordinary laboratory data can be directly applied but, in general, there is a gap between the strength of a specimen and the strength of a part designed on the basis of this specimen's strength. The gap is increased considerably by the above-mentioned new factors, and the old method of closing this gap by means of increased factors of safety becomes dangerous and expensive. This is where the science of Metal Mechanics enters. It takes into account all those features and minor factors that differentiate a design element from a test specimen. In reality these factors are not minor, for due to them it may happen that while a specimen made of material A is stronger than the identical specimen made of material B, an actual part made of material A is weaker than the identical part made of material B.

The purpose of Metal Mechanics is not only to explain such facts but also to supply data which will permit the designer to make a correct estimate of the real strength of design parts and thus avoid needlessly large or danger-

MICHAEL V. ZAUSTIN, research engineer, Jet Propulsion Laboratory, California Institute of Technology, has in recent years, been interested in establishing a close working relationship between strength of design elements and the properties of the materials of which they are made under strict requirements of light weight, safety, and specific environmental conditions.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

ously small factors of safety. The ideal of modern design engineering is to leave to the margin of safety only those factors of strength which by their nature belong to the field of probability—such factors as nonuniformity of material, uncertainties of production and unexpected behavior of loading. But even these factors may be treated with mathematical exactness by the theory of probability.

The Behavior of Metals Assumed in the Theory of Elasticity Is Not Realistic

While materials data are based on idealized and standardized test conditions, stress analysis also suffers from simplifications and assumptions that are often far from realistic. The theory of elasticity deals with deformations and stresses in the elastic range but entirely ignores the fact that most failures occur in the plastic range. For this reason, the stresses calculated from ordinary formulas are often not the final design stresses, since they represent the actual conditions only in the simplest cases, and often must be altered to satisfy the existing conditions. Here is where the role of Metal Mechanics would serve as a connecting link between the strength of a part and the strength of a metal.

Modern engineering cannot be satisfied with the fundamental assumption of isotropy or perfect elasticity. It seeks to take into account such factors as directionality of mechanical properties of materials, using different moduli of elasticity in different directions: transverse and longitudinal, tensile and compressive. In some other cases, precision designing rejects Hooke's relationship and replaces it with stress-strain curves because the proportionality between stresses and strains is only approximate in many cases (for example, aluminum alloys, stainless steels, etc.). In such cases we have to use tangent, secant, and reduced moduli. There are other cases in which the classical theory of elasticity should be modified to take into account "anelastic" effects that cause the deformation to be a nonlinear function of applied stresses. Such, for instance, is the case of a vibrating body with internal friction, when energy must be supplied to maintain vibrations at a constant amplitude.

From these examples we see the need for having stress-strain data, not only in the elastic range but in the plastic range as well, and not only for tension but also for compression.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

Nonuniform Stress Distribution Requires Special Test Data

When stresses are not uniformly distributed, the theory of elasticity again comes into conflict with reality, due to the fact that yield and ultimate strengths belong to the domain of plastic deformations.

If, for instance, we subject a beam to bending by a moment which is calculated from the ordinary bending formula, using a value for the yield strength based on 0.2 per cent permanent elongation, we will find that permanent elongation of the outermost fiber will be less than 0.2 per cent, probably 0.15 per cent. To obtain a permanent deformation of 0.2 per cent we will have to increase the load, sometimes 20 per cent or more. The explanation is simple. The inner fibers of the beam, which are stretched elastically, pull back the outer fibers, which are stretched plastically and thus reduce the permanent set. A similar situation is observed in cases of torsion, or in any other cases where stress gradient is present.

This is an important situation, because one of the most general principles of rational design is the use of the same criterion of strength for all design elements. In this case the same permanent deformation that is used for yield strength should be used for bending. Adherence to this principle may result in a considerable saving of weight. Since, in bending and torsion cases the magnitude of the residual deformation depends on the relationship between the elastic and plastic properties of a material, and since this relationship cannot be derived from ordinary tensile data, the design engineer must have special experimental data for bending and torsion in the form of moment-deformation or stress-strain curves.

Many Questions About the Behavior of Metals Are Unanswered

The theory of elasticity fails to answer many questions. Why does an axial force, applied to a specimen in tension, produce a component that is perpendicular to the axis causing the Poisson's effect? Why does a cube made of brittle material, subjected to compression, fracture in tension? Or, what right have we to apply the results of a tension test of a metal, which forms a neck before breaking, to the calculations of strength of a pressure vessel which breaks without forming a neck or a noticeable plastic deformation? What right do we have to use the yield of ultimate tensile strength, which belongs to the plastic range, in formulas (for bending and torsion) which are derived for the elastic range? Or, why do we have so many theories of strength, none of which gives a reliable answer?

The use of the strongest material is often far from being the correct solution in designing the strongest part. For instance, when the strongest material is used for making bolts, it does not always result in the strongest bolts. In selecting material for a pressurized tank, an inexperienced designer may wish to take advantage of the high mechanical properties of a steel heat-treated to a high strength, without realizing that a greater ductility of the same material, treated to a lower strength, will more than compensate him with respect to strength and safety. Again, selection of a half-hard material for a strut in compression often results in a stronger strut than would use of a full-hard material, because of its greater degree of straightness. Parts with stress concentrations made of stronger metals are often weaker than identical parts made of weaker but more ductile material. With steels of medium strength of the order of 120,000 psi ultimate tensile strength, fatigue limits are often obtained that are almost equal—sometimes even superior to—those of steels of practically twice the static strength (1).[1] There are many other facts that arise as soon as we begin to consider the accuracy of strength prediction as a primary factor of design for minimum weight and maximum safety.

Existing Data Need Improvement

When one begins to collect and systematize the existing data on strength of materials, he is discouraged by the lack of the most important information on the most ordinary materials, such as SAE carbon steels or aluminum alloys. For instance, there are no data on cross-sectional reduction of aluminum alloys or shear-strength data on carbon steels. And, in whatever data can be found, there is often no indication under what conditions it was obtained, that is, speed of deformation, surface condition of the specimen, direction of fiber, size of the piece from which the specimen was cut, number of specimens tested, etc. In giving the limit of elasticity or yield strength, the amount of permanent deformation is often omitted.

The situation has not changed since it was described by Clyde Williams (2) in the following words: "As soon as we start dealing with fine details, the problem of gathering data becomes astonishingly complicated. The mate-

rial problem may be stated simply by saying that the materials engineer does not know what properties to measure. The data that have been obtained in the past are of most value in estimating the relative worth of materials and are usually not suitable for use by the designer."

THE VARIABLE NATURE OF THE STRENGTH OF METALS

In order to deal successfully with the above-mentioned and similar problems, one has to understand the nature of the strength of materials, which is a result of the combination of properties of materials and the properties of stresses.

Only deeper detailed study of the relationship between the properties of materials and the properties of stresses will explain many phenomena and answer many questions hitherto unanswered, as well as enable us to obtain more realistic data on the mechanical properties of materials.

Not so long ago it was believed that a material always possesses the same mechanical properties, regardless of the kind of forces applied and regardless of the character of stresses.

Now we know that brittleness and ductility, for instance, are not inherent properties but only mechanical states of a metal. We know that the character of stresses and the mode of their application may change the properties of a material even to a greater degree than do chemical composition, heat treatment, or temperature.

The Duality of Stresses

No matter what the external forces are, three kinds of stresses appear together: tensile, compressive, and shear. Compressive stress as such cannot produce a fracture and, from the standpoint of strength, only tensile and shear stresses need be considered. The only difference between various forces is that they produce various ratios of tangential (shear) stress to normal (tensile) stress. This ratio is the most important characteristic of stresses and of their effect on the strength of materials. Its value for compression is 2:1, for torsion 1:1 and for tension 1:2; in cases of pressurized vessels, plates, etc., its value is less than 1:2

The greater the value of these ratios the "softer" is the state of stresses, that is, the greater is the tendency of the stresses to produce a ductile deformation and ductile (shear) fracture. Thus, compression is the "softest" state of stresses. The "hardest" state of stresses occurs when the principal stresses are both tensile and equal, because the shear stresses in this case are zero. Indeed,

$$\tau = \frac{\sigma_1 - \sigma_2}{2} = 0$$

if

$$\sigma_1 = \sigma_2$$

Various Effects of the Patterns of Stresses

The fact that stresses may be hard or soft is important. By changing the pattern of stresses we may obtain the whole spectrum of ductility from a brittle to a plastic state.

There are many experimental facts that prove these statements. It is a known fact that marble and cast iron can be extruded by triaxial compression. It was done experimentally and is being done today in nature. Under tremendous triaxial pressure in the earth's crust, igneous and sedimentary rocks, which are quite brittle in simple compression, have been made to flow like a viscous body.

Cast iron, some aluminum alloys, and many other alloys that are brittle in tension (1 to 2 per cent elongation) show a considerable ductility in torsion and become quite ductile in compression (10 to 20 per cent elongation). Modern high-strength (low tempering temperature) steels have small ductility in tension (2 to 3 per cent) but are reasonably ductile in torsion. For all ductile materials, the shearing elastic limits, as found from torsion tests, are much less than the tensile elastic limit, as found from tests (**3**). Steels that become brittle at low temperatures have considerably higher temperature of transition to brittle state in tension than in torsion (**4**). Tanks made of relatively ductile aluminum alloy 7075S-T6, when subjected to internal pressure and some additional longitudinal tension, burst into fragments, like glass (**5**). In any case of stress concentration, brittle fractures occur as a result of increased normal stresses at the expense of tangential stresses. Wire, drawn through dies, shows a much greater ductility than when drawn without dies because the side pressure of a die increases the tangential stress. A sharp difference was shown between impact tests in bending and in torsion.

These examples indicate the close relationship between stress pattern, ductility, and strength of metals. They also indicate that the selection of the type of mechanical test is important for evaluation of the suitability of a metal for a given design element.

If we denote the principal tangential stress with τ and the principal normal stress with σ, the condition for propensity for a brittle fracture will be when $\tau < \sigma$ and for a ductile fracture when $\tau > \sigma$.

We say "propensity" because the final result depends also on the properties of a metal.

The Duality of the Resistance of Metals to Stresses

For the explanation of the ductile and brittle behavior of metals, it is not sufficient to recognize the obvious effect of the dual nature of stresses. This behavior is also a result of the dual character of the resistance of metals: the shear resistance which opposes the tangential stress, and the technical cohesion resistance which opposes the normal stress. Like the two types of stresses, shear and cohesive resistances also have entirely different natures. Shear resistance is the resistance of particles to slip—a plastic phenomenon. The technical cohesive resistance is the resistance of a metal to tearing off by a normal stress—an elastic phenomenon.

We used the word "technical" (which in future will be omitted) because in the physics of solids cohesive resistance is an ideal case of molecular attraction, while in engineering we deal with the cohesive resistance, weakened by structural imperfections, presence of foreign atoms, microscopic cracks, etc. It may be defined as an ability of metals to resist fracture by the normal stresses and it is measured by special tension tests that exclude the effect of plastic deformation.

If we denote the shearing strength of a metal with t and the cohesive strength with s, the condition of propensity of the metal for a brittle fracture will occur when $t > s$ and the propensity for ductile failure will occur when $t < s$. Any change of the pattern of stresses (τ/σ ratio) or of the properties of material (temperature, strain hardening, heat treating) produces a change in the ability of the material to resist external forces—normal and tangential stresses.

The General Condition of Ductility and Brittleness

The effect of stress patterns in conjunction with the effects of fundamental properties of materials (t and s), as a contributing factor of strength, brittleness, and ductility, is one of the most important problems of our times.

When stresses increase, a failure occurs, and the type of the failure—ductile or brittle—depends on which resistance, shear or cohesive, is overcome first.

If the shear resistance is overcome first by the tangential stress, we have:

$$\tau_{max} = t$$

and

$$\sigma_{max} < s$$

or

$$\frac{\tau_{max}}{\sigma_{max}} > \frac{t}{s}$$

This is the condition of shear (ductile) failure.

If the cohesive resistance is overcome first, the condition of brittle fracture will be:

$$\frac{\tau_{max}}{\sigma_{max}} < \frac{t}{s}$$

Thus, the character of a fracture *does not depend on the absolute values of stresses and strengths* but on their *ratios*. This conclusion fundamentally changes the old concept that each material has only one mode of fracture. It may be safely stated that the adherence to this one sided idea retarded the development of a rational unified theory of strength. It was responsible for the split of all theories of strength into two groups, without any indication of which group should be used in each given case. It retarded also the proper understanding of the nature of ductility, brittleness, and the strength of materials in general.

The Unified Condition of Strength

The above-derived inequalities permit us to make a decision as to which one of the two groups of theories of strength should be used. The first group must be used when cohesive strength is overcome first by the maximum normal stress and the second group when the shear strength is overcome first by the tangential stress. Thus, the unity of conditions of strength may be achieved only by introduction of cohesive strength as a criterion of strength:

$$s_{coh} > \sigma_{max}$$

and

$$t_{yp} > \sqrt{\tfrac{1}{2}(\sigma_1 - \sigma_2)^2 + (\sigma_1 - \sigma_3)^2 + (\sigma_2 - \sigma_3)^2}$$

Conditions of Brittle Fracture

Another important conclusion is that a brittle fracture may occur as a result of several causes. Since shear resistance is sensitive to all conditions of tests, we may expect a brittle fracture under any one of those conditions that increase the shear resistance and make it greater than the cohesive resistance. This may happen under the following conditions:

Low temperature,
High speed of deformation, and
Change in crystalline state, such as is caused by heat treatment or strain hardening.

On the other hand, brittle fracture may be caused by reducing the tangential stress so much that the cohesive strength is overcome first by the normal stress. This is done by using biaxial and triaxial stresses.

While there is a considerable amount of data in the first group, practically no data are available on the mechanical properties of metals at various stress patterns. The most urgently needed data right now are on the effect of combined stresses on tensile yield strength, breaking tensile strength, hardness, etc. The need for such information will continue to exist until a method utilizing shear and cohesive strengths for any combination of stresses will be perfected.

Fracture of ductile materials, caused by normal stresses, was never considered in terms of measurable quantities. Unexpected brittle fracture of ductile materials was never explained and could not be explained without consideration of the dual nature of stresses and strength. Fatigue and stress concentrations were usually blamed for a fracture. All our present tests of strength of ductile materials reveal the resistance to plastic deformations under the action of tangential stresses (uniaxial tension, torsion, shear, compression) and the possibility of fracture of a ductile material by normal stresses was never considered in evaluation of mechanical properties nor in engineering calculations and design.

It is true that shear and cohesive strengths were known for a long time, but cohesive strength was never used as an engineering criterion.

The important problems of testing materials are not only to determine cohesive and shearing strengths of various materials but also to investigate their properties individually.

While shearing resistance obeys the laws analogous to those of fluid mechanics, that is, it depends on the speed of deformation (flow), geometry, and temperature, cohesive strength appears to be little dependent on these factors. Cohesive strength of water, for instance, is 75 psi (according to Reynolds (**6**)), while the cohesive strength of ice is 90 psi or less.

These two properties of metals are the most fundamental constants of the materials because, unlike tensile strength, they are elementary. The development of methods for determination of these properties should be an important part of research at present, and it is not a simple problem where determination is needed in cases of shear strength of brittle materials and cohesive strength of ductile materials.

The Importance of Cohesive Strength Data

A question arises—is cohesive strength a really important property of metals? Since we managed to get along for a long time without it, why do we need it now?

In the first place, it is impossible to predict brittleness or ductility of the design elements under a full load, especially with combined stresses, without knowing the value of cohesive and shear strengths.

Such prediction becomes very important when factors of safety are small. Never before in the history of engineering have there been so many structures, subjected to the action of combined stresses, designed and built as there are now; and these are the cases where the application of the principle of duality of stress and strength would be most beneficial.

The strength of pressurized vessels, pressurized airplane cabins, all kinds of plates, etc., cannot be determined with confidence without consideration of the dual nature of stresses and strength, especially in designs for ultimate (collapse) values of loads. The most important application of the duality principle is to the selection of a safe material—a material which will not become brittle under combined stresses. This point is so important that it should be introduced into the pressure vessel codes.

These are the combined stresses produced by the external forces but there are equally dangerous stresses of the internal origin: residual stresses, the stresses produced by stress raisers and probably fatigue loading. It is well known that the first two kinds of stresses are biaxial and triaxial stresses which are responsible for a brittle fracture. It was recently found that fatigue loading reduces cohesive strength and, therefore, high cohesive resistance is desirable for fatigue-resistance (**7**). Thus, for development of metals suitable for construction of pressurized structures and of metals resistant to stress concentrations, residual stresses, and fatigue, metallurgical research should look for metals with high cohesive strength.

There is no reason why, if tangential and normal stresses in a component are known on one hand and shear and cohesive strengths on the other, we could not determine directly the strength and safe dimensions of a design member, without referring to the unreliable theories of strength. There are many other cases where knowledge of cohesive strength is important.

Even if we are concerned with plastic

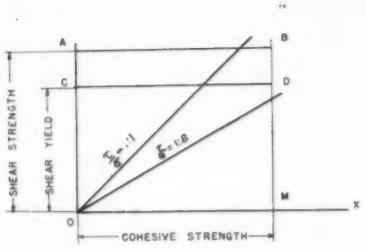

Fig. 1—Stress-strength diagram.

properties of metals, cohesive strength is an important property because when a metal is being formed or drawn, it must have sufficient strength to resist the normal stresses arising from the process. On the other hand, for machinability cohesive strength should not be very high in order to facilitate breaking of chips. Sulfur, selenium, or lead are often added to steel to reduce the cohesive strength.

Stress-Strength Diagram

In this diagram (Fig. 1) the horizontal lines, *ab* and *cd*, represent shear yield strength and shear ultimate strength. The vertical line, *mn*, represents cohesive strength. As to the stresses, for each type of loading the ratio of tangential to normal stress is constant and is represented by a ray passing the origin. The angle between each ray and the *X* axis is determined by the ratio τ/σ. If such a diagram were supplied by the manufacturers in addition to the usual mechanical properties of metals, they would greatly facilitate the selection of materials for a given application and even the selection of the theory of strength to be used, because they enable not only prediction of the type of possible fracture but also estimation of how far a material under a given load is from the brittle state. Consider, for instance, the tension ray ($\tau/\sigma = 1:2$). It intersects first the line of cohesive resistance indicating brittle state and brittle fracture. At the same time the torsion ray ($\tau/\sigma = 1:1$) intersects first the shear yield line, indicating ductile yielding. Such conditions might occur in the case of a high-strength steel, tempered at a very low temperature.

In this diagram all lines are straight. This is only a first approximation. In reality none of the lines will remain straight under a load. The determination of these curves for various materials and for various stress systems is one of the most important problems of modern research in the study of the behavior and strength of materials under various types of stressing.

Since stresses change the properties of materials, stress analysis does not give a complete answer about the strength of a design element. It must be supplemented, if not replaced, by the strength analysis, which takes into consideration the effect of stresses on the mechanical properties of materials.

SUGGESTIONS FOR THE IMPROVEMENT OF METHODS OF TESTING MATERIALS

Tension

Tensile strength is an almost forgotten property of metals, as far as study of its nature and proper use of materials are concerned. It is treated as a simple property, whereas in reality it is the most complex of all mechanical properties of metals.

The measured value of tensile strength, as was shown, is the result of a combination of shear and cohesive strengths in a proportion not revealed by the test. If we test a cast-iron bar in tension we measure mainly its cohesive strength; but if we measure the tensile strength of an aluminum bar, we obtain a quantity that is mainly a function of its shearing strength. Yet we call both tests results tensile strength.

The results of tension tests may be applied directly and with confidence only to the structural members in simple tension, but they cannot be used directly when, for instance, we have biaxial tension. In such a case it is customary to use one of the theories of strength which is supposed to determine the magnitude of stress at which yielding begins. But what theory should be used in a given case? This usual answer is that for brittle or near brittle materials the so-called first and second theories should be used and for ductile materials the others. But what materials should be called brittle or ductile? This is a difficult question to answer, unless we have shear and cohesive strengths and stresses corresponding to them, as was shown before.

It follows that tensile strength data from the design standpoint is only a special case of resistance of bars in tension, just as buckling strength is a special case of resistance of slender structural members to axial compression. Thus, the investigation of tensile strength must be conducted as a combination of two resistances the value of which must be determined separately for various materials under various conditions of stressing and temperature.

Compression

The usual compression tests of cubic specimens made of brittle materials indicate that they break diagonally and consequently in shear. This is puzzling, since it is known that all brittle materials have greater shear than tensile resistance. But if the top and bottom of the cubic specimen are lubricated, the fracture occurs in tension, along the planes parallel to the compressive force. This is important because it becomes possible to determine the ratio of tangential stress to normal tensile stress, in the case of compression. An experiment was made, using as a specimen a glass cube. Subjected to compression, the cube gave a compressive strength of 3770 psi. On the other hand, tension tests gave a tensile strength of 877 psi and Poisson's ratio 0.25. Having in mind the Poisson's ratio and assuming that stresses are proportional to deformations, we may determine the tensile strength by dividing the compressive strength by four: that is 3770:4 = 942 psi, while the measured tensile strength was 877 psi. The difference may be explained by the effect of friction on the specimen against the plates of the press and the difficulty of accurate measurement of tensile strength, due to the sensitivity of the brittle specimens to misalignment. In such a case the ratio we are looking for will be:

$$\frac{\tau}{\sigma_{tens}} = \frac{\sigma_{comp.}}{2} : \frac{\sigma_{comp}}{4} = 2$$

Torsion

Testing of materials under torsion deserves much more attention than it is usually given. Unlike tension, it produces simple stresses. The cross-section of a round bar in torsion has only shear stresses and no normal stresses. The plane under a 45-deg angle to the axis has maximum normal stresses and no shear stresses. This makes a torsion fracture a distinct criterion of relative strength of the material in shear or tension (under normal stress). Because of a different ratio τ/σ in cases of torsion and tension, the shearing elastic limit determined is much less than that determined from tension tests. As to the yield point, the question arises as to what permanent set should be used in order to make it comparable to the yield point in tension.

Using the theory of plasticity, it can be proved that the equivalent permanent deformation for torsion is 1.5 of the permanent deformation for tension (**8**).

$$\gamma = 1.5\epsilon$$

if

$$\epsilon = 0.002$$
$$\gamma = 0.003$$

Shear Strength

Despite the fact that shear strength has been used in engineering for a long time, the existing data are scarce and often unsatisfactory, probably because of the belief that shear strength is a definite fraction of tensile strength. At least one textbook on machine design gives shear strength for all materials as 0.6 of the tensile strength. In reality this fraction is different for different metals and even for different states of the same metal. For instance:

Monel, soft $\frac{T}{S} = 0.7$

Monel, hard $\frac{T}{S} = 0.56$

Nickel, soft $\frac{T}{S} = 0.77$

Nickel, hard $\frac{T}{S} = 0.63$

Inconel, soft $\frac{T}{S} = 0.71$

Inconel, hard $\frac{T}{S} = 0.54$

Duranickel, soft $\frac{T}{S} = 0.64$

Duranickel, hard $\frac{T}{S} = 0.5$

The magnitude of shear strength becomes an especially important factor in the light of duality of strength. Because of the sensitivity of shear strength to temperature, speed of deformation, stress character, and crystalline state, shear strength becomes a controlling factor of the mechanical properties. Consequently, the experimental data on properties of shear strength under various conditions (speed of deformation, temperature) are needed. Shear strength is determined in several ways, but each method requires further investigation and development. Direct single and double shear is not free from friction and bending effects. Torsion of thin tubes involves danger of loss of stability, and torsion of solid cylindrical bars is affected by the nonuniform stress distribution. With the development of the theory of plasticity, the last method becomes more attractive. Considerable research is needed to obtain more accurate shear data for various materials and agreement among various methods of testing.

Stress Concentrations

We have a considerable amount of theoretical and experimental data on the weakening effect of stress concentrations, but all existing data are for the elastic range. It is a well-known fact that in cases of ductile metals notches have no weakening effect and in many cases they have a strengthening effect. The difference is a matter of ductility, but the question arises as to which metals have this ability and which do not. The most reliable data on the effect of notches in static tests are obtained by the use of the specimen shown in Fig. 2.

The use of such a specimen is equivalent to the use of two specimens made of the same material and subjected to the same load under identical conditions of test. The position of the fracture—in the smooth or notched part—indicates the negative or positive effect of the notch. In the first case the fracture occurs in the notch (then $\sigma_n < \sigma_s$) and in the second case on the smooth part ($\sigma_n > \sigma_s$). In this latter case, by testing several specimens we may find such a diameter of notch that the strength of the notched and smooth parts will be equal. If D is the diameter of the smooth part and d of the notch, we may then establish a coefficient that characterizes the effect of the notch and the propensity of the material for brittleness:

$$\beta = \frac{\sigma_n - \sigma_s}{\sigma_s} = \frac{D^2 - d^2}{d^2} = \frac{D^2}{d^2} - 1$$

where:

$$\sigma_n = \frac{4F}{\pi d^2}$$

and

$$\sigma_s = \frac{4F}{\pi D_2}$$

where F is the common maximum load that the specimen is able to sustain in the smooth and notched parts.

Obviously when $\beta > 0$, the effect of the notch is positive, and the greater the value of β the more reliable is the material in design.

If the fracture takes place through the notch, in order to obtain equal strength of the notch and the smooth part it is necessary to increase the diameter of the notch. In such a case $\sigma_n < \sigma_s$ and $d > D$, that is, the effect of the notch is negative. This method is somewhat complicated, but it gives a numerical answer, although it is not free from some degree of arbitrariness, due to the effect of shape and size. It is very simple, however, to make simple qualitative tests. It would be very desirable to add to the properties of each material its mode of fracture in the form of the above described specimen, in other words, to classify the materials as having positive or negative effect of the notch. Since the stress

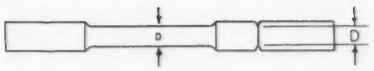

Fig. 2.—Notch specimen for static tests.

concentration always causes an increase of normal stresses that are resisted by the cohesive resistance, the search for best material with best resistance to stress concentrations is the search for a material with greatest cohesive resistance, as was noted before.

Impact

Single impact tests have no value for design purposes except in comparison and selection of materials from the shock and notch resistance standpoint. But impact tests made in series, for instance, tests of the same specimens at various temperatures, permit the establishment of the zone of brittleness and maximum ductility for each material.

At higher temperatures, the speed effect is not sufficient to produce a cohesive fracture. Only when the temperature drops to a certain level, does the shear resistance become stronger than the cohesive resistance, and the specimen breaks in a brittle manner.

As is the case in mechanical tests at present, impact tests must be conducted at elevated temperatures as well as at room temperature. The data for elevated temperatures are necessary not only for designing structures operating at elevated temperatures but for developing technological processes, such as drop forging or hot rolling (9).

Fatigue

When a part is subjected to simultaneous action of constant and variable loads, the endurance limit is often determined by means of a diagram of the Goodman type. These diagrams do not agree with experimental data because they are based on correlation of two phenomena of differing nature: fatigue strength and tensile or yield strength. The only correct solution to this problem is the experimental determination of fatigue strength for various combinations of steady and variable loads and plotting them in the form of Smith's diagram. This kind of data is quite common in foreign literature but practically nonexistent in our own data books.

Another important problem in the investigation of fatigue strength of metals is the development of a method of determining endurance strength from short-time tests. In this respect, study of mechanical hysteresis and resistance to vibrations is a promising field.

Data on fatigue strength at a small number of cycles and high stress are often required in military applications but are seldom available to the designers.

Ductility Data Should Be Widened

Ductility is much more used in engineering than is generally supposed. The principle of St. Venant states that the stress distribution at a certain distance from an applied force does not depend on the actual distribution of this force but only on its total value. This phenomenon is made possible only by the anelastic response of the material. Otherwise a crack, caused by a concentrated force, once started, would propagate without being stopped by a plastic flow. Thus, local anelasticity is a prerequisite for safe service of any structure designed for the elastic range.

We use ductility when we neglect residual stresses or additional stresses from stress concentrations; we rely upon it when designing riveted joints and we use it deliberately when straightening and fitting beams, plates, or bars, when bending, forming, drawing, etc., sheets and bars.

In view of the great importance of this property of metals, it is strange that up to the present time it has received but scant attention from materials engineers. Seldom can more data on ductility be found than elongation at fracture in 2 in. These data cannot be used in design and their only use is in comparing ductility of materials. This is not an accurate measure of ductility because it depends not only on the shape of the specimen but also on the gage length. For instance, the elongation of a flat bar may be as much as 20 per cent smaller than the elongation of a round bar. For the designer, the elongation in 100 in. has much greater value and for a technologist the reduction of the cross-section and the elongation at "zero length" gage is more important. Cross-sectional reduction indicates better than elongation the forming properties of a metal. Zero length elongation is still better in this respect. It may be calculated from the formula:

$$\delta = \frac{\psi}{1 - \psi}$$

This formula is determined as follows: Since in the plastic range the volume practically does not change

$$A_0 L_0 = A_F(L_0 + \lambda) = A_F L_0 (1 + \delta) \quad \ldots\ldots\ldots\ldots (1)$$

where:

A_0 and A_F are initial and final cross-sections,

L_0 and L_F are initial and final lengths, and

δ is the relative elongation.

Since the relative reduction of area is

$$\psi = \frac{(A_0 - A_F)}{A_0}$$

combining this expression with Eq 1 we obtain

$$\delta = \psi/(1\text{-}\psi).$$

We may repeat here that stress-strain curves are good indicators of ductility in simple cases. Since ductility depends upon the type of stressing and tension is rather a hard type stress, in some cases ductility may be better determined by torsion tests. For instance, high-strength steels show very little ductility in tension but considerably more in torsion.

The above-described measures of ductility are not always comparable. For instance, it often happens that alloy A has a greater elongation than alloy B, but judging by reduction of the area, alloy B is more ductile. Thus, there is a need for a more reliable index of ductility. If we had shear and cohesive strengths, such index of ductility could be obtained from the above-derived condition of ductile deformation and failure:

$$\frac{\tau_{max}}{\sigma_{max}} > \frac{t}{s}$$

or

$$\frac{\tau_{max} s}{\sigma_{max} t} > 1$$

or

$$\frac{\tau_{max}}{\sigma_{max}} \frac{s}{t} = 1 + \alpha$$

This is the index of true ductility under a stress. For tension it will be $s/2t > 1$; for torsion $s/t > 1$; for compression $2s/t > 1$.

In the previous equation the value of α may be called the margin of ductility since the condition $\alpha = 0$ is on the boundary of ductility and brittleness.

The values of these ratios are the measures of ductility under various modes of stresses. The greater the ratio the greater is the ductility. When this ratio is close to unity the material under stress is close to brittleness.

This method of evaluation of ductility permits us to calculate its index of ductility for combined stress. In such a case:

$$\tau_{max} = \frac{\sigma_1 - \sigma_3}{2}; \quad \sigma_{max} = \sigma_1 - \mu(\sigma_2 + \sigma_3)$$

and the index of ductility:

$$\frac{\tau_{max}}{\sigma_{max}} = \frac{(\sigma_1 - \sigma_3)}{2\sigma_1 t - 0.5(\sigma_2 + \sigma_3)t}$$

The value of μ is assumed to equal 0.25.

The recognition of cohesive strength as a missing link in evaluation of ductility of metals under load will help us to approach the problems of heat treatment with open eyes. For instance, for a long time it was believed that alloy 4340 is brittle if treated to 280,000 to 290,000 psi, but it was found experimentally that by reducing the temperature of tempering from 800 to 900 F to 400 to 450 F it retains enough ductility. Then the question arises as to where the limit of increased strength and reduced ductility is. The answer may be obtained by determining the ratio of the shearing and cohesive strengths and using the above inequality for each type of stressing.

The cross-sectional reduction is justly considered by several authors as a better index of ductility for cold and hot forming (9) operations, because it does not depend upon the gage length and characterizes the maximum deformation under conditions of test. Otherwise, it has the same defect as elongation since it does not give a complete picture of plastic flow of metal. It consists of two deformations different in nature—uniform and localized—combined in different proportions in various metals. For instance, for high-strength steels the uniform deformation is only 5 to 10 per cent of the total; for aluminum alloys it is 18 to 20 per cent and for brasses 35 to 45 per cent. When the temperature in a specimen is lowered, the uniform deformation changes little and in some cases even increases, whereas the localized deformation increases considerably. Again, if subjected to impact, the uniform deformation is little affected, as compared with static tests, but the localized deformation is considerably smaller. These facts, together with the fact that only the uniform deformation is utilized in technological processes, make necessary separate investigation of uniform and localized deformations.

The determination of uniform deformation does not require any special tests. All that is needed is to measure, in addition to the diameter of the neck, the diameter of the straight part of the specimen. For purposes of comparison it is convenient to express the deformations as relative elongations. The relative elongation at the neck is the zero gage elongation, and the uniform relative elongation is calculated from the same formula as zero gage elongation by substituting the initial and the final diameters of the straight part of the specimen in the expression for ψ.

The Effects of Elevated Temperatures

We have considerable and satisfactory data on creep, that is, longtime effect of heat on strength and elongation at

relatively low temperatures under a constant load. But we do not have enough data for some modern requirements as, for instance, combination of high rate of loading with high rate of heating. However, the rate of heating appears to be not very important. What is important is the temperature. Some tests indicate a certain increase of tensile strength with the increased rate of heating, but this increase may be ascribed to the effect of increased speed of deformation and sensitivity of the resistance of hot metals to the speed of deformation.

One might expect that at high temperatures, when the crystalline changes take place, the rate of heating might affect the strength of metals indirectly by affecting, for instance, the formation of austenite in carbon steels. Recent investigations of R. A. Huggins and others at the Massachusetts Institute of Technology (10) indicate that the rate of heating has no appreciable effect on formation of austenite. This is a fortunate fact because the high-rate heating tests may be simplified and reduced to the tests of metals at high temperatures and a convenient rate of heating, as well as tests for the effect of speed of deformation at elevated temperatures. Certainly the rate of heating is important when we are concerned with thermal shock. But this phenomenon is dangerous only when the material is brittle and has low thermal conductivity.

In addition to tensile strength, other mechanical properties are needed including the modulus of elasticity. Modulus of elasticity is best determined by the vibrational method. Longitudinal vibrations are used for determination of tensile and compressive moduli and torsional vibrations for determination of shear modulus. Another way to determine the modulus of elasticity at elevated temperatures is based on the fact that the ratio of the thermal coefficient of the modulus of elasticity to coefficient of thermal expansion is constant for all metals. This method requires the knowledge of the coefficient of thermal expansion but its determination is relatively simple.

In short-time heating tests, the mode of heating is important, since electric heating is practically uniform, whereas gas heating spreads gradually from the heated surface.

Strength-temperature curves are very desirable, since materials that are strongest at elevated temperatures, such as high-strength aluminum alloys, are much more adversely affected by high temperatures than is, for instance, 2024S-T4 alloy.

Effects of Low Temperatures

Data on effects of low temperatures are necessary in designing refrigerating machinery and the equipment for handling gases in liquid state. Investigation of metals and alloys from the standpoint of brittleness at low temperatures is very important, but the available data about the transition point are not abundant. Another scarcely investigated problem is the strength of metals at room temperature, after they are subjected to low temperature; and the problems of thermal fatigue caused by alternating low and room temperatures.

The Thermal Properties of Materials

Thermal tests include thermal conductivity, heat capacity, and thermal expansion. As soon as we begin to design for elevated temperatures, the problems of heat transfer arise. These problems cannot be solved accurately unless we know the heat conductivity and heat capacity as functions of temperatures. The value of thermal conductivity, for instance, changes by the factor 2 or more. Unfortunately, very few data of this kind were published despite the fact that modern methods of instant registration of temperature permit quick and simple determinations of thermal properties of materials. Using such methods, it was possible to establish thermal conductivity of SAE 1020 steel almost up to the melting point and to discover that there are two reversing points of the curve of thermal conductivity *versus* temperature, corresponding to steel transformations from α to γ and from γ to δ.

The Need of Complete Stress-Strain Curves

Tensile properties of metals are best described by the stress-strain curves. There are many engineering problems in which it is important to have complete stress-strain curves. These curves are necessary for many reasons. The most important reason is that their absence reduces the usefulness of the modern theory of plasticity. The mathematical theory of plasticity owes its development to the demand for more realistic and accurate determination of safety factors of structures, since the failure of most structures occurs in the plastic range. It receives increasing attention as the basis of a rational design method, especially design of statically indeterminate structures, such as rigidly joined frames made of aluminum, stainless steel, and mild and low-carbon steels.

Stress-strain curves are necessary in designing for maximum load (collapse load) instead of maximum stress. This method is more and more used because of its more realistic approach to the problem of strength and safety. In many cases where this method is applicable, a considerable saving of weight is obtained. In cases of variable loading of statically indetermined structures, stress-strain relationship is necessary for determination of the "shake-down" state of stresses, that is, the limits of variable loading that make the structure work within the new elastic range, created by the initial overloading.

Accurate stress-strain curves are necessary for determination of the usual mechanical properties of metals, such as modulus of elasticity, limits of elasticity and proportionality, yield point, ultimate strength, and breaking strength. These properties are different in torsion and must also be determined there. It is important to have them not only for room temperature but for low and elevated temperatures as well. They are necessary also for determination of tangent and secant moduli of such materials as aluminum and magnesium alloys, stainless steels, titanium, and for all metals at elevated temperatures. It often happens that a material that is the strongest at low stresses and elongations, becomes the weakest at high stresses; or a material which is the strongest at room temperature becomes the weakest at high temperature. In such cases stress-strain curves, drawn on the same diagram, clearly show the point where the difference changes its sign.

Without stress-strain curves, the development of metal-working operations and rational design of equipment for these operations is practically impossible, since stress-strain curves determine not only the limits of formability but also the elastic setback and other factors of design when permanent plastic strains are used. The shape of a stress-strain curve already gives an idea of the technological properties of a metal.

An entirely new metal can be evaluated safely if its stress-strain curve is available. In the future, the principal tools of a designer will be accurate stress-strain curves drawn with double lines, indicating minimum and maximum values. The most useful tool of the materials test engineer will be testing machines that automatically draw accurate stress-strain curves.

The Need of the True Stress-Strain Curves

The true stress-strain curves are becoming more and more important with the development of the use of the theory of plasticity. The true stress is

obtained by dividing the tensile force by the cross-section at the time the stress was measured. In the area of necking the effect of the shape of the neck has a reinforcing effect which should be calculated and deducted from the values obtained by the tests. This correction may be as much as 20 per cent. It is necessary because its effect is the effect of shape and has nothing to do with the properties of metal. True stress is widely used in the study of plastic deformations and also of elastic deformations, when they are large as in the case of rubber. Cast iron and some cast aluminum alloys have small deformations, and the difference between the nominal and true stresses is negligible, but in the case of some stainless steels it is considerable. For instance, the nominal strength of an 18–8 alloy was about 109,000 psi, while the true stress was 203,000 psi, almost twice as great.

True stress-deformation curves do not show the ultimate strength, but they clearly give the measure of strain hardening.

The true stress-strain curves are important when we want to correlate tensile data with those of other forms of test, such as torsion and bending. It is important for the solution of the general problems of yielding and failure under conditions different from the test conditions, as in the case of combined stress conditions in structures or in hot and cold forming operations. The ductility of a metal and the effect of strain hardening are more accurately determined by true stress-strain diagrams than by the use of conventional elongation in 2 in. The true elongation is cumulative, being related to the changing length of the specimen. It has deep physical meaning of the total quantity of physically appearing deformations at various values of stresses.

The Need of Probability Distribution Data on Strength of Materials

Even if large factors of safety are used in the determination of allowable stresses, failures occur. The reason is that the so-called minimum or guaranteed values of strength of materials are not the absolute minimum. From the safety and reliability standpoint it is not so much the values of minimum or average strengths that concern a design-engineer but rather the *scatter of the experimental results* which characterize for him the uniformity of material. The minimum values are guaranteed in the sense that no one of the relatively small lot of specimens will fall below the specified value. If one does fail, the lot of material from which the specimens were taken will be replaced. Thus, only a curve of probability distribution of the experimental data on a large number of tests can give us a real picture of the strength of the material. Now, having another curve of probability distribution of stresses, we may obtain a curve of probability distribution of factors of safety. Such a curve tells us what factor of safety we should select if the percentage of failure is prescribed. This approach to the problem of safety is clear and definite, as contrasted with the ambiguous statement that a structural member is designed for a factor of safety of 2 or 3. The procedure may be explained this way: Suppose we have a bag filled with balls and on each ball is marked the tensile strength obtained in material test laboratory. Another bag is filled with an equal number of balls and on each ball is marked a stress that occurs in a member in consideration under various service conditions. Now we take simultaneously one ball from each bag and, dividing the strength of the material by the stress, we obtain the factor of safety. Continuing this process, we may construct a histogram of the factor of safety and thus find the relationship between various factors of safety and the corresponding number of failures.

Summary

The results of tension tests constitute the foundation upon which our knowledge of strength of materials is built. But this foundation is not always firm. This is because we consider the tensile properties as elementary single properties, whereas in reality they are composite and tensile resistance consists of two resistances—shear and cohesive, which respond differently to different stresses. For this reason, only in cases of pure tensile stresses may the tensile data be used directly in engineering calculations. In other cases, however, in order to use tensile data, we must resort to several theories of strength without any assurance that the selected theory will give us good results. Only by studying these two properties individually will we be able not only to solve the problems of strength and deformation directly, under various combinations of stresses, but also to explain many phenomena of strength and ductility which are not clear at present. For instance, such as increase of strength of metals with increased rate of strain, transition from ductile to brittle state with lowered temperature, embrittling effect of tensile stress triaxiality, dual nature of fatigue, etc. Probably the most fruitful results of this outlook will be obtained in metallurgy in the development of alloys with prescribed mechanical properties, that is, definite value of shear and cohesive resistances.

There are reasons to believe that our adherence to the tensile phenomena as a single elementary property is responsible for the fact that the science of experimental strength of materials has not made progress comparable with the progress in electronics, aerodynamics, or hydrodynamics. Thus shear and cohesive strengths are very important properties necessary for deeper understanding of the strength of materials. Unfortunately, the property of shear is neglected by investigators, despite the fact that it is a more fundamental property than tension.

Consideration of the dual nature of strength of materials will give us a better degree of safety and protection against catastrophic failures of pressurized aeroplane cabins and other pressurized structures.

We have very few data on the phenomenon of reduction of cross-section and none at all on the most important part of it, namely, the uniform reduction, just before necking begins. These phenomena are closely related to shear. This is the part of plastic deformation which is utilized in the fabrication of metals.

Another property related to shear resistance, which was not previously studied, is the resistance of thin plates and sheets to ripping or tearing (11).

We need more data for each material and coverage of more materials in various physical states, at various temperatures, and at various rates of deformation. The existing data are incomplete and in some cases inaccurate. In most cases the discrepancy is the result of omission of some conditions of test, such as the rate of strain, shape (flat, round) and size of specimen, direction of rolling, temperature, time element (aging, relaxation) and even chemical composition and crystalline structure.

There are some mechanical properties which are important but not available: for instance, volumetric changes during heat treatment are important from the standpoint of cracking during heat treatment. Another important, but little investigated property, is internal friction. This property is very important in the study of vibrations, when taking into consideration the dissipation of energy in the material. Vibrations, like fatigue, in recent years occupy attention of design engineers of airplanes, missiles, automobiles, and high-speed machinery.

Another important group of properties which is in great demand among

modern designers is the thermal properties of materials. These properties have little value for a designer unless they are given as functions of temperature, since they vary with temperature by the factor 2 or more. Even for the most common materials, we do not have these data at the temperatures used in modern engineering. Reflectivity should be added to the usual list of thermal properties since its effect on the heating rate may be as high as 20 per cent.

More detailed data may often change the decision of a designer from a strong material to a weaker one. For instance, if one of two materials is weaker but the test data show smaller scatter, the designer may decide in favor of the weaker material, use a smaller factor of safety and thus not only reduce the weight but have the advantage of greater ductility. Certainly, to achieve this he needs statistical data. When using cold-worked austenitic stainless steels for webs and struts in compression, we may gain weight by employing half-hard material instead of stronger full-hard material, because the half-hard material is straighter and will, therefore, resist buckling conditions better. We may select softer and weaker material for a part made by cold working operations and obtain a stronger part than by using the same material in a stronger state. But to do it intelligently we need strain-hardening data—that is, true stress-strain curves.

When designing a pressure vessel, we may again find that the material with the highest tensile strength does not always produce the strongest vessel, if the reserve of ductility of this material is not sufficient to prevent the embrittling effect of combined tensile stresses.

If we draw in the same coordinates stress-strain curves for two different materials, we may find that they intersect. This will indicate that one material is preferable for low stresses, while the other is preferable for high stresses. Similarly, we may find that materials which are stronger at room temperature are not necessarily stronger at elevated temperatures.

All this indicates that the usual data on properties of materials are not sufficient for designing with confidence light, strong and reliable structures.

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California oil story (Vesper), No. 220, Feb., 21.
quality control laboratory (Duncan), No. 219, Jan., 40 (TP12).
Plastics
accelerated fatigue (Lazar) No. 220, Feb., 67 (TP55).
epoxy
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glass-reinforced
creep (Goldfein), No. 225, Oct., 29, (TP179)(*R*).
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reinforced
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Vicat softening point test (Stephenson and Willbourn), No. 224, Sept., 28 (TP148).
President's Talks
expanding technology and ASTM, Annual address (Schatzel), No. 223, July, 53.
Printed Circuits
foil-clad laminates (Schlabach, Wright, Broyer, and Rider), No. 222, May, 25 (TP93).
Progress Report
insulating materials
thermal stability of varnished fabric development of test methods, No. 221, April, 74.
Proposed Methods
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definition of noncombustibility, No. 220, Feb., 33.
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silicones (Cahn), No. 222, May, 30 (TP98) Disc., 34 (TP102).
Provisional Progress
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Publications
new ASTM publications, No. 219, Jan., 13, 14; No. 220, Feb., 10; No. 221, April, 23; No. 222, May, 6; No. 223, July, 37; No. 224, Sept., 5; No. 225, Oct., 5.; No. 226, Dec., 7.

R

Radioactive Materials
corrosion and heat-treatment (Calkins, Whitney, and Lusk), No. 224, Sept., 25 (TP145).
Railroad Industry
standardization and research (Corbett), No. 222, May, 14.
Random Samples, No. 222, May, 17; No. 223, July, 45; No. 224, Sept., 19.
Research
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Roof Surfaces
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Rubber
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new SBR numbers, No. 224, Sept., 18.
synthetic
standard samples, No. 220, Feb., 92.
use of specifications in buying (Stringfield), No. 220, Feb., 39 (TP27). Disc., 40 (TP28).

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Sheet Materials
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at elevated temperatures (Molander, Waldron, and Newland), No. 225, Oct., 37 (TP187).
Silicones
protective coatings industry
(Cahn), No. 222, May, 30 (TP98). Disc., 34 (TP102).
Shipping Containers
first 50 years of committee D-10, No. 220, Feb., 24.
Soil Removal
water-soluble
drycleaning (Fulton, Lloyd, Loibl, Moore, and Reichard), No. 219, Jan., 50 (TP22).
Solvent Degreasing
(Kircher), No. 219, Jan., 44 (T16) (*R*). Disc., 4 (TP21).
Sonic Testing
mechanical properties of solid materials (Kesler and Chang), No. 225, Oct., 40 (TP190)(*R*).
Sorptive Mineral Materials
new ASTM committee organized, No. 221, April, 35.
Specifications
sampling plans in ASTM specifications, No. 223, July, 47.
drain tile (Miller), No. 221, April, 47.
Standardization
actions on standards, No. 219, Jan., 12; No. 221, April, 21; No. 222, May, 7; No. 224, Sept., 6; No. 225, Oct., 15; No. 226, Dec. 6.
railroad industry, No. 222, May, 15.
Steel
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production and fabrication (Hinkle), No. 220, Feb., 47 (TP35).
stainless
stress-corrosion cracking (Dana), No. 225, Oct., 46 (TP196). Disc., 52 (TP202).
stressed in torsion
strength and fatigue life (Hendrickson), No. 224, Sept., 40 (TP160).
Strain Rate Effect
machine with instantaneous speed change (Manjoine, Wessel and Pryle), No. 226, Dec., 31 (TP219)(*R*).
Strength of Materials
necessity of research (Zaustin), No. 226, Dec., 52 (TP240)
Strontium Oxide
in portland cements (Bean), No. 224, Sept., 42 (TP162).

T

Technical Committee Notes, No. 219, Jan., 23; No. 220, Feb., 16; No. 22, May, 12; No. 223, July, 22, 43; No. 225, Oct., 17, 18; No. 226, Dec., 20.
Testing Machines
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Textile
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Thermal-Shock Testing
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U

Ultrasonic Testing
of aluminum alloys (Fink), No. 226, Dec., 36(TP224). Disc., 41 (TP229).
Unhydrated Magnesia
determination
in dolomitic lime hydrates (Trattner), No. 225, Oct., 53 (TP203).
Unsolved Problems, No. 225, Oct., 21.

W

Wood Poles
for communication lines (Lumsden), No. 222, May, 19 (TP87) (*R*).
research program, No. 224, Sept., 16.

The Bookshelf

Fatigue in Aircraft Structures

Edited by Alfred M. Freudenthal; Academic Press Inc., New York, N. Y.; 500 pp.; $13.

THIS volume contains the papers and discussions, presented at an international conference held at Columbia University early in 1956. The sponsors of the meeting were the Solid State Sciences Division, Air Research and Development Command, USAF, and Columbia's Guggenheim Institute of Flight Structures.

The purpose of the meeting was, in part, "to bring together the physicists and physical metallurgists, the test engineers and aircraft designers . . . in an attempt to bridge the gaps between the three groups and to stimulate the work on the various aspects of fatigue by exchange of information between research workers in the various groups."

As main organizer of the meeting, Professor Freudenthal was not only eminently successful in enlisting leading workers in all these fields as contributors, but also in giving a truly international flavor to the meeting. Besides the USA, England, France, Germany, and Sweden were represented.

The papers were divided into three groups: physical mechanism of fatigue and fatigue theories, fatigue testing and test-interpretation (prediction of fatigue life and fatigue strength), and fatigue design (prevention of fatigue failure). The first group stands fairly clearly by itself; the division line between the other two groups, however, is less distinct.

Of the five papers grouped under Physical Theories of Fatigue, three originated in England indicating that England still maintains the high level of interest in basic fatigue research which it has held for half a century, although the limited total number of contributors (19) resulted perhaps in a sample that is a bit unfair to the USA in this respect.

The most striking impression one obtains from this group of papers is the wealth of detail observations on slip bands, documented by many excellent photographs. These observations, together with those on precipitation bands, the extrusion phenomena observed by Forsythe, and on the formation of cracks, furnish much food for thought. What might be termed "theory," however, for instance, the discussion of dislocations, is rather subdued, at least by comparison.

The second and the third group of papers (14 total) were contributed by engineers rather than physicists or physical metallurgists. Perhaps in a class by itself is the first one: the rather startling (and discussion-provoking) observations reported by C. E. Phillips on nonpropagating cracks. Statistical methods of test evaluation receive their due share of attention, as does the problem of cumulative damage. The aircraft fatigue engineer is not yet in the position where design loads are spelled out by codes and specifications; thus, a number of the papers discuss the problem of establishing design loads. Generalized trend studies are presented which aim at setting design allowable stresses—the most practical approach for fatigue design. Desirable improvements in stress analysis are pointed out and the integration of fatigue design and fatigue development testing into the conventional static design procedures are discussed.

The fatigue testing of large components and complete aircraft presents larger-scale problems than rotating-beam testing; thus, several papers give extensive descriptions of the testing of helicopters, airplane wings, and pressurized fuselages. Service experiences and development tests are recounted in detail—the type of information that all too often remains locked in company files because it is considered to be the basis for the "know-how" of the company. Papers of this type are presented from England, Sweden, and the USA, thus giving a well-rounded and up-to-date picture of practical fatigue engineering, including such features as "fail-safe" design.

The book is neither a primer nor a handbook on fatigue, and it was not intended to be so. To the aircraft structural engineer, however, it presents a comprehensive and up-to-date perspective of fatigue engineering, and by way of the references listed in the papers, an excellent guide to the literature for more detailed studies. While such items as loads are of interest chiefly to aircraft engineers, the discussions of fatigue laws and fatigue engineering will be of interest to engineers in many other fields.

To what extent the conference was successful in the partial purpose quoted earlier—to bridge the gap between physicists, physical metallurgists, and engineers—is difficult to judge; the record of the discussion suggests that comments on papers in any one group were made, in general, by workers in this same group. There is no question, however, that the conference was eminently successful in achieving its other purposes: to clarify issues and to broaden knowledge, and the book will extend these benefits to a much wider circle.

PAUL KUHN

Protective Painting of Structural Steel

Fancutt and Hudson; The Macmillan Co., London; 91 pp.; $4.50.

THE synopsis is an excellent summary of the findings of many years of effort and intrigues the reader to proceed further to determine how surface preparation and painting procedures influence the ultimate performance of the paint coating.

There are hints, precautions, and information in the book which are of interest to the painting contractor, the maintenance engineer, the paint formulator, and the structural steel designer. Fancutt and Hudson ably steer a middle course with something of value and interest for all.

The book is clearly and concisely written and is a valuable guide to the busy individual who does not have time to read the references which contain the details of the respective tests.

If individuals concerned with the protection of steel structures would or could adhere to the advice and precautions suggested by the authors, this reviewer is sure the paint formulator, maintenance engineer, and painting contractor would have fewer ulcers and less need for aspirin and soda.

The language is clear, direct and factual. It is not so simple as to insult the intelligence of the more experienced reader; neither is it so lofty technically that one not versed in scientific terms could not readily grasp the important points. For the serious literature searcher the book is amply replete with numerous references.

In some cases the references in the text might be a little clearer and the continuity of the book would be improved if the figures were placed consecutively throughout the text.

The photographs in Plate IV give every one reason to pause and reflect that the best is cheapest if long-term economical protection is desired. In

(*Continued on page 99*)

BOOKS RECEIVED

ENGINEERING PROPERTIES AND APPLICATION OF PLASTICS. G. F. Kinney, John Wiley & Sons, Inc., New York, N. Y.

ENGINEERING METALLURGY. Committee on Metallurgy, Pitman Publishing Corp., New York, N. Y.

MANUAL OF CONCRETE INSPECTION. American Concrete Inst., Detroit, Mich.

TRANSACTIONS. 1957, Society of Rheology, Vol. 1.

STATISTICAL METHODS IN RESEARCH AND PRODUCTION. Oliver & Boyd, London, England.

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A TREATISE ON PHOTOELASTICITY. Coker and Filon, Cambridge University Press, Cambridge, England.

METALLURGICAL PROGRESS—3. Philosophical Library, New York, N. Y.

DIRECTORY. 1947 American Inst. Mining, Metallurgical and Petroleum Engineers.

GLASS REINFORCED PLASTICS. P. Morgan, (Ed.), Philosophical Library, New York, N. Y.

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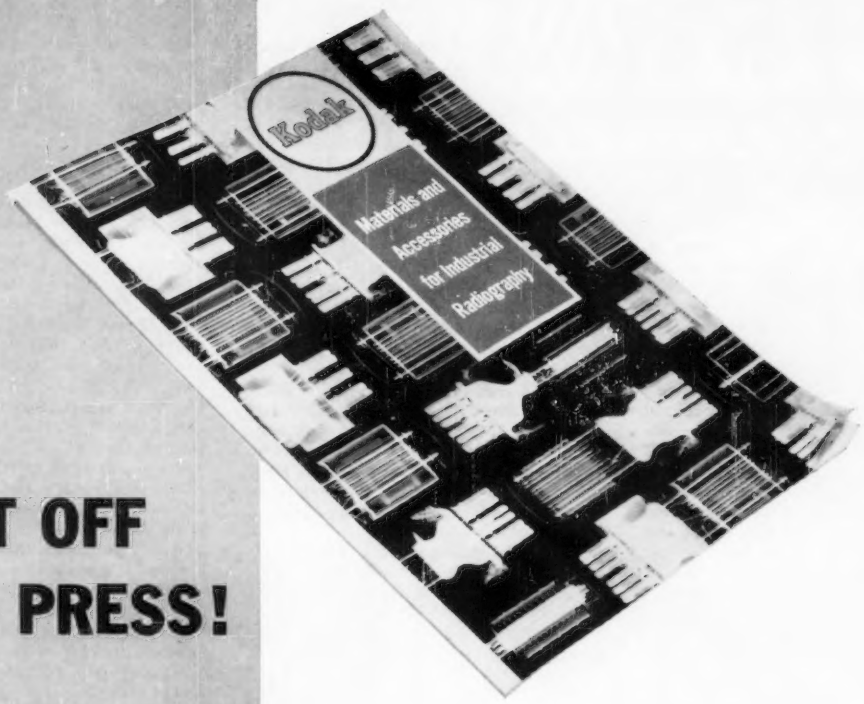

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PERSONALS . . .

News items concerning the activities of our members will be welcomed for inclusion in this column

A number of ASTM members were among those honored at the recent annual meeting of the American Society of Civil Engineers. **Waldo G. Bowman,** editor of *Engineering News-Record,* became ASCE Vice-President for Zone I. **Tilton E. Shelburne,** director of research for the Virginia Council of Highway Investigation, was the choice for director for District 6. The new director for district 9 is **Craig P. Hazelet,** consultant and senior partner in the firm of Hazelet and Erdal, consulting engineers of Louisville, Ky. **Whitney C. Huntington,** retired head of the civil engineering department, University of Illinois, was elevated to ASCE honorary membership. **Alfred M. Freudenthal,** professor of civil engineering at Columbia University, was the second-time winner of the Norman Medal, oldest and most coveted of the ASCE awards; his prize-winning paper was entitled "Safety and the Probability of Structural Failure." **Ernest C. Hartmann,** research engineer and chief of the Engineering Design Div., Aluminum Research Laboratories, with two collaborators, was awarded the Thomas Fitch Rowland Prize for the paper "Design of Aluminum-Alloy Beam-Columns." **Glenn B. Woodruff,** consultant and bridge engineer of San Francisco, with two co-authors, received the James Laurie Prize for their paper "The Vibrations of Steel Stacks." **Wesley G. Holtz** and a co-worker at the Bureau of Reclamation were awarded the Arthur M. Wellington Prize for their paper "Engineering Properties of Expansive Clay." **William E. Dean, Jr.,** Bridge Division, Florida State Road Dept., received the recently established Ernest E. Howard Award for "his outstanding contribution and pioneer work in the design and use of prestressed and post-tension reinforced concrete, particularly as related to work in bridge construction."

American Chemical Society Division officers also include several active ASTM members. **Victor R. Deitz,** of the National Bureau of Standards, is new chairman of the Division of Carbohydrate Chemistry. **Leo B. Genung,** of Eastman Kodak Co., heads the Division of Cellulose Chemistry; **Herman F. Mark,** Polytechnic Institute, Brooklyn, is chairman-elect. **L. Reed Brantley,** head of Occidental College's chemistry department, is chairman of the Division of Paint, Plastics, and Printing Ink. **Harold M. Smith,** of the U. S. Bureau of Mines at Bartlesville, Okla., heads the Division of Petroleum Chemistry.

At the annual meeting of the Association of Consulting Chemists and Chemical Engineers in New York City in October, **Lincoln T. Work,** consulting chemical engineer of New York City was elected ACCCE president. **Sam Tour,** of Sam Tour & Co., Inc., was elected treasurer. Both Messrs. Work and Tour are longtime active ASTM members, contributing consistently for more than 30 years to the technical committee and district work. Dr. Work is a past-secretary and current vice-chairman of the ASTM New York District Council. **Herman F. Mark,** director of polymer research, Polytechnic Institute of Brooklyn, also active in ASTM technical work, was the keynote speaker at the ACCCE meeting; his address concerned "Synthetic Organics—Present and Future." Among those named ACCCE councilors for three-year terms were **A. G. Ashcroft** of Arthur D. Little, Inc.; and **David R. Schwarz** and **Eugene W. K. Schwarz** of Schwarz Laboratories. Holdover councilors included the following ASTM members: **Joseph W. E. Harrisson** of LaWall & Harrisson; **Nicholas M. Molnar** of Fine Organics, Inc.; **Donald Price** of Oakite Products, Inc.; **Cecil M. Shilstone,** Shilstone Testing Laboratory; and **Emerson Venable,** consulting chemist and engineer.

The following ASTM members participated in the XXX^e Congres International de Chimie Industrielle, American Section Program, in Athens, Greece, September 19: **Ray P. Dinsmore** of Goodyear Tire and Rubber Co.; **Hillary Robinette, Jr.** of Robinette Research Laboratories, and **Roger Williams** of Roger Williams Technical and Economic Services, Inc.

Raul J. Akot, until his recent appointment as production manager, Pacific Welding Alloys (Phil.), Inc., Manila, was the chief engineer of Overseas Gas Corp., Manila. A chemical engineer by profession, Mr. Akot has distinguished himself for years in the welding industry and pioneered in the research and development of the first welding electrode plant in the Philippines. He recently completed several months of studies at various European and American electrode plants for the improvement of welding technology in his country.

Richard C. Alden, chairman for many years of Phillips Petroleum Co. Research Planning Board and director of research for over 17 years, has chosen early retirement, which became effective November 1.

A member of the ASTM Board of Directors and chairman of its important Long-Range Planning Committee, which work is now actively under way, Mr. Alden

(*Continued on page 74*)

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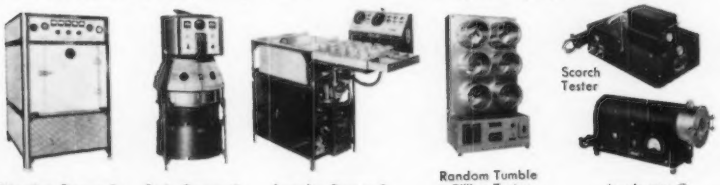

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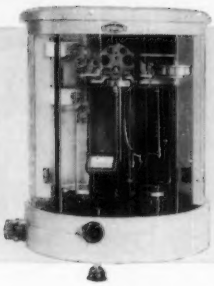

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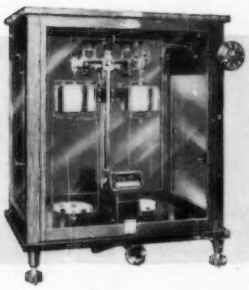

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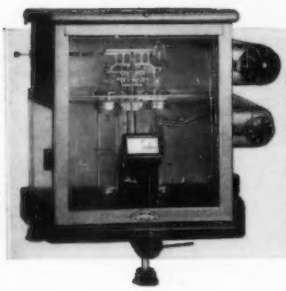

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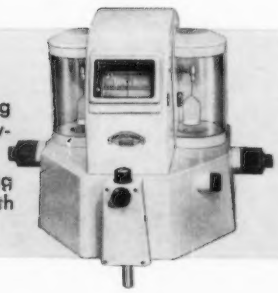

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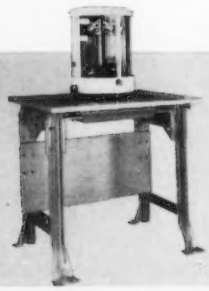

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Personals

(*Continued from page 70*)

will continue as a consultant to the company and will continue as a representative in certain industry, trade, and technical association work.

The announcement from the president and chairman of the board of the Phillips Co. noted among other points that Mr. Alden made major contributions to the outstanding developments which have come from Phillips laboratories and pilot plants. He also is a technical pioneer in the development of the natural gasoline industry.

W. Garwood Bacon, formerly vice-president, E. W. Twitchell, Inc., Philadelphia, Pa., is now New York district manager, The Landers Corp., Riverton, N. J.

Edgar C. Bain retired September 30 as assistant executive vice-president of operations, United States Steel Corp., Pittsburgh, after nearly 30 years of service. In 1928 he headed the metallurgical department in the newly formed Research Laboratory at Kearny, N. J. Later, he was vice-president of research and technology. Distinguished in the metallurgical field, he has been recognized nationally and internationally by many awards and medals. One of the major buildings of U. S. Steel's Research Center in Monroeville, Pa., is named the Edgar C. Bain Laboratory of Fundamental Research in his honor. Dr. Bain resides at 513 Maple Lane, Edgeworth, Sewickley, Pa. A longtime member of ASTM, he served for many years on Committee E-4 on Metallography.

O. A. Battista, head of American Viscose (Marcus Hook, Pa.) analytical group, research and development division, is author of the recently published book, "God's World and You" dealing with the resources of the sea and its ability to feed the population of the world. He is author of another book, "How to Enjoy Work and Get More Fun Out of Life," the November choice of the Executive Book Club. In ASTM, Dr. Battista is active in Committee D-23 on Cellulose and Cellulose Derivatives, currently serving as vice-chairman.

ASTM Past-President **L. C. Beard, Jr.,** coordinator of research, Socony Mobil Labs., Socony Mobil Oil Co., Inc., New York City, presented a paper at the API meeting in November, summarizing extensive work done in API Research Project No. 45 which dealt with antiknock properties of pure hydrocarbons and their blends. The Society is cooperating in bringing together the extensive knock-rating data in a forthcoming publication.

Bernard J. Beierla has been appointed chief metallurgist, Springfield Foundry Co., Indian Orchard, Mass., in charge of metallurgy, sand, and quality control. For the past 17 years he held a similar position with E. W. Bliss Co., Toledo, Ohio.

Donald J. Bergman, chief engineer, Universal Oil Products Co., Des Plaines, Ill., received an Award of Merit from the Chicago Technical Societies Council for contributions to science, civic affairs, and the Chicago community.

Fred C. Blanchard, formerly highway design engineer with Porter W. McDonnell, consulting engineer, Toledo, Ohio, is now highway design engineer, Arizona Highway Dept., Tucson, Ariz.

John M. Campbell, scientific director, Research Staff, General Motors Corp., was honored by selection as the 1957 Horning Memorial Lecturer. This lecture honors SAE Past-President Harry L. Horning, a pioneer in the automobile industry; and the award recognizes distinguished, active service in the mutual adaptation of fuels and engines. A former National Director of ASTM, Mr. Campbell gave the lecture in Cleveland on November 7. The title was "Looking Ahead in Fuels for Automotive Transportation." Among other things Mr. Campbell said that he believed hydrocarbons in the general form of gasoline, with certain modifications in volatility and molecular structure for optimizing fuel economy and combustion characteristics will remain for many years as the most suitable form of energy for automotive transportation. He went on to point out, however, that we do need more efficient methods for the conversion of the chemical energy into mechanical or electrical energy.

(*Continued on page 76*)

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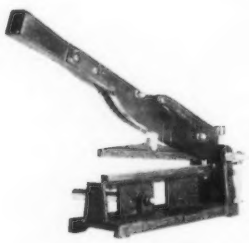

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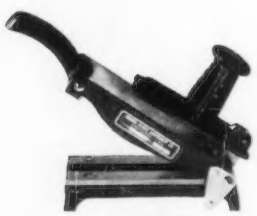

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Personals

(*Continued from page 74*)

Robert L. Carpenter, until recently with Empire State Oil Co., Thermopolis, Wyo., is now chemist, Dow Chemical Co., Rocky Flats Plant, Denver, Colo.

Eric M. P. Caunce has been promoted from chief chemist and metallurgist with the Ford Motor Co. of Canada, Ltd., to manager of the chemical and metallurgical department manufacturing staff of the company.

Tien-Sun Chang, formerly instructor at the University of Illinois, Urbana, is now associate professor, Virginia Polytechnic Inst., Blacksburg, Va.

Gerald G. Christiansen, until recently with California Portland Cement Co., Colton, is sales representative, L. Sonneborn Sons, Inc., San Francisco, Calif.

Donald L. Colwell has been elected vice-president in charge of laboratories and research, Apex Smelting Co., Chicago, Ill. Associated with the company for 12 years, he was formerly director of laboratories. A longtime ASTM member, Mr. Colwell has been very active in several of the nonferrous technical committees. He currently is serving as vice-chairman of Committee B-7 on Light Metals and Alloys, also is active in district work of the Society.

Eric B. Evans, chief chemist of Esso Research, Ltd., Abingdon, England, received the Eastlake Medal of the Institute of Petroleum for outstanding services to the Institute.

John F. Ewing has been appointed metallurgist supervisor of research, Tubular Products Div., The Babcock & Wilcox Co., Beaver Falls, Pa., with responsibility for the supervision of research studies and alloy development. He continues his work as secretary of the company's Superheater Materials Committee.

J. F. Fairman, vice-president, Consolidated Edison Company of New York, has been elected a director of the National Association of Manufacturers.

Martin C. Falk, formerly chief engineer, Steel Equipment Co., Cleveland, Ohio, is now associated with Westinghouse Electric Corp., Pittsburgh, Pa., as supervisor, design section, Headquarters Mfg. Labs.

R. L. Foster, until recently with American Builders, Inc., Colorado Springs, Colo., has accepted a position with Diversified Builders, Inc., Patrick AFB, Fla.

W. K. Fuchs is now research and development engineer with Insulation Products, Ltd., Vanderbijl Park, Transvaal, South Africa.

J. C. Geniesse for many years divisional director of Research, Research and Development Dept., Atlantic Refining Co., Philadelphia, Pa., is now manager of the newly created product development and technical services, marketing department. He has given outstanding service for many years in the work of Committee D-2 on Petroleum Products and Lubricants, particularly involving problems of viscosity. He served on the Administrative Committee on Papers and Publications, and has assisted in other phases of ASTM activities.

Roy M. Green, formerly dean of engineering, University of Nebraska, Lincoln, has opened offices as consulting engineer at 1845 S. 41st St., Lincoln, Nebr.

A. S. Gregory has been promoted to manager of the newly organized Central Research Dept., Weyerhaeuser Timber Co., Longview, Wash.

Martin H. Gurley, Jr., formerly with Thermoid Co., Trenton, N. J., now has offices as consultant at 5935 Creola Rd., Charlotte, N. C.

J. W. Halley has been promoted to chief of research and development, Research and Development Dept., Inland Steel Co.

Joseph D. Hanawalt, vice-president and manager, Magnesium Dept., Dow Chemical Co., Midland, Mich., was among an exchange group of metallurgical scientists who recently visited metallurgical laboratories, plants, and institutions in the Soviet Union.

Maurice F. Halser, director of research, Applied Research Labs., Glendale, Calif., received the Beckman Award in Chemical Instrumentation, sponsored by Beckman Instruments, Inc., Fullerton, Calif., for contributions to instruments and techniques suitable for industrial use of spectrochemical analysis. Dr. Hasler is very active in ASTM Committee E-2 on Emission Spectroscopy.

W. D. Hatfield, of the Sanitation District of Decatur, Ill., received a distinguished service award from the American Chemical Division of Water, Sewage, and Sanitation Chemistry. Dr. Hatfield serves as liaison representative of the Federation of Sewage and Industrial Waste Assns. on ASTM Committee D-19 on Industrial Water.

Maurice E. Hatten is now chemical engineer, Armco Steel Corp., Trenton, Ohio.

Albert G. Haynes, formerly with Oscar C. Rixson Co., Franklin Park, Ill., is owner and director of engineering and operation, Leo-Aries Industries, Maywood, Ill.

Russell W. Henke, R. Henke Associates, Elm Grove, Wis., was winner of $750 and a National Silver Certificate for his paper "Analytical Design Leads to Re-

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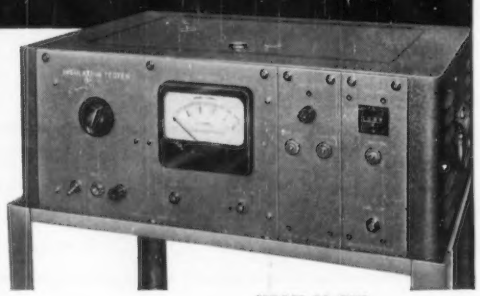

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placements of Weldments with Steel Castings in Compaction Heavyweight" entered in the third Product Development Contest of the Steel Founder's Society of America.

S. C. Hollister, dean of engineering, Cornell University, Ithaca, N. Y., has been appointed to a special technical staff to advise the House Merchant Marine Committee on the question of widening the Panama Canal or building a second canal in Central America.

Milton E. Holmberg, metallurgical consultant, Houston, Tex., and past-chairman of the ASTM Southwest District, has been named chairman of the recently formed Committee (T8) on Refining Industry Corrosion of the National Association of Corrosion Engineers.

E. H. Holzworth has retired as president of Frontier Bronze Corp., Niagara Falls, N. Y. He is succeeded by **Theodore H. Booth.**

Herbert J. Hoodwin, until recently with the Building Div., City of Miami, Fla., is now head of H. J. Hoodwin and Associates, consulting engineers, in Miami.

E. H. Horlebein, president, Gibson & Kirk Co., Baltimore, Md., represented the non-ferrous castings industry at the President's Conference on Technical and Distribution Research for the Benefit of Small Business. Mr. Horlebein is a past-president of the American Foundrymen's Society and the Non-Ferrous Founders' Society.

Allen G. Hotchkiss, manager of engineering-special furnace heat processing equipment, Industrial Heating Dept., General Electric Co., Shelbyville, Ind., received the Trinks Industrial Heating Award for his pioneering developments in protective atmospheres. His citation included mention of his development of exothermic and Neutralene generators at General Electric and the introduction of exothermic gas in copper brazing.

James R. Hunter, manager, Materials Engineering Dept., Bettis Atomic Power Div., Westinghouse Electric Corp., Pittsburgh, Pa., has been awarded the Westinghouse Order of Merit, the highest honor the company confers, for his guidance of materials application for atomic power plants.

George K. Iwashita, formerly with General Electric Co., Commercial Products Dept., Air Conditioning Div., Bloomfield, N. J., is now manager, advanced planning, Curtiss-Wright Corp., Buffalo, N. Y.

Kenneth E. Jones, chief engineer, Joe Stine, Inc., Houston, Tex., was awarded $200 and a Blue Certificate for his paper "Castings for Oil Wells at Sea" entered in the third Product Development Contest of the Steel Founders' Society of America.

(*Please turn page*)

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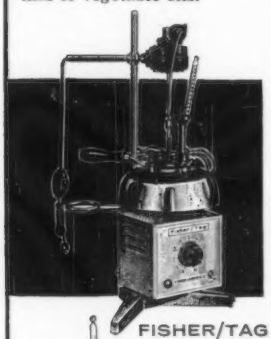
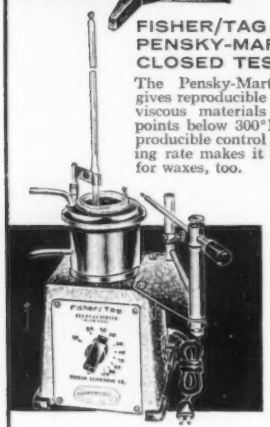
There is an improved Fisher/Tag Flash Point Tester for every official ASTM method: open and closed models, electrical, alcohol and gas-operated. Each instrument gives you complete control of every step in your flash point tests of petroleum products, asphalts and animal or vegetable oils.



FISHER/TAG PENSKY-MARTENS CLOSED TESTER

The Pensky-Martens Tester gives reproducible results with viscous materials with flash points below 300°F. Full, reproducible control of the heating rate makes it easy to use for waxes, too.



FISHER/TAG TAG OPEN TESTER

The new Fisher/Tag Open Tester increases the reproducibility of tests for determining flash points of paints, varnishes, lacquers, vegetable oils and related products which flash below 175°F.

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ICIRCLE 720 ON READER SERVICE CARD
PAGE 105

Personals

(*Continued from page 77*)

Edwin Joyce recently retired from the American Petroleum Inst., Division of Production, Dallas, Tex. Mr. Joyce, who has been active in the work of the ASTM Southwest District and currently serves as a vice-chairman of this group, plans to continue to make his home in Dallas at 4323 Gloster Rd.

Theodore Kapala, chief of the chemistry section of the chemicals and plastics division, Quartermaster Research and Engineering Center, Natick, Mass., and J. Fred Oesterling, chief of the division, each received a Certificate of Achievement for their joint presentation of an outstanding paper at the first Army Science Conference. They also received Special Act or Service Certificates and $125 each from the Center for "exceptional contribution to the advancement of the Research and Development Program of the Army."

John R. Kauffman, formerly with Tuttle & Kift, Inc., Chicago, Ill., is now president, Speedster, Inc., Denver, Colo.

Ruffin H. Keedy, until recently with Revco, Inc., Deerfield, Mich., is now partner, Acme Electric, Fort Worth, Tex.

Edward W. Kilpatrick has retired as state highway engineer of New Jersey. He is now engaged as a consultant, at 409 Church St., Hackettstown, N. J.

John D. Kleis has been appointed vice-president and director of research, Fansteel Metallurgical Corp., North Chicago, Ill. He was formerly manager, electrical contact division.

Duane K. Kniebes has been promoted from head of the analytical division at the Institute of Gas Technology, Illinois Institute of Technology, Chicago, to assistant research director.

Eric A. Kolm was the 1957 (first) recipient of the Du Pont Award of the Society for Nondestructive Testing, Inc., recognizing significant contributions to nondestructive testing. Mr. Kolm is a member of ASTM Committee E-7 on Nondestructive Testing and several of the subcommittees.

ASTM President **Richard T. Kropf** represented the Society at the President's Conference on Technical and Distribution Research for the Benefit of Small Business, held in Washington in September. He reported the conference well attended and stimulating, with its primary objective that of helping the small businessman in the areas indicated through presentation of data on sources of research and development assistance available for this large segment of industry—approximately 300,000 manufacturers. ASTM, of course, is uniquely representative of one of the cited sources of such aid so vitally needed by all businessmen in our current economy and the present technological era.

Basil T. Lanphier has been promoted to manager of research, Carpenter Steel Co., Reading, Pa. He formerly was metallurgist for stainless and high-temperature alloys.

Harold W. Lownie, Jr., chief, Process Metallurgy Research Div., Battelle Memorial Inst., Columbus, Ohio, was elected chairman of the Gray Iron Division of the American Foundrymen's Society. Previously he served as the Division's vice-chairman. Mr. Lownie is assistant secretary of ASTM Committee A-3 on Cast Iron, and chairman of the subgroup concerned with general castings.

Erwin M. Lurie, until recently with the Field Service Div., Office of the Quartermaster General, U. S. Dept. of the Army, is now materials engineer, Veterans Administration, Washington, D. C.

Vincent T. Malcolm, for many years director of research of the Chapman Valve Manufacturing Co., Indian Orchard, Mass. has retired from the company but is continuing a number of his ASTM and other society activities. A member of ASTM for more than 35 years, he will continue active in the Joint ASTM-ASME Committee on Effect of Temperature on the Properties of Metals, of which he is chairman; also will continue his membership on Committee A-1 on Steel. Mr. Malcolm is active too in code work in committees sponsored by ASME and other groups which are concerned with boiler code and pressure vessel problems.

ASTM Past-President **L. J. Markwardt** was the speaker at the Luncheon of the Wood Industries Division of The American Society of Mechanical Engineers during the recent ASME meeting in New York City.

Don M. McCutcheon, for many years on the engineering staff of Ford Motor Co., Dearborn, Mich., and more recently consultant in engineering physics, Madeira Beach, Fla., is now assistant to division manager staff, Westinghouse Electric Corp., Atomic Power Div., Bettis Field, Pittsburgh, Pa. Mr. McCutcheon has been very active in several of the technical committees of the Society. He served as chairman of Committee E-10 on Radioisotopes and Radiation Effects for two years; and as secretary of Committee E-7 on Nondestructive Testing for a similar period. He also is a past-officer of the Detroit District Council.

Robert C. McMaster, professor of nondestructive testing, Ohio State University, Columbus, was the 1957 recipient of the Coolidge Award of the Society for Nondestructive Testing, in recognition of his "outstanding contributions to the industrial application of X-ray; his meritorious service to the society as SNT Handbook editor, and to the profession through his radiographic and fluoroscopic research, development and educational accomplishments." Dr. McMaster has been a member of ASTM Committee E-7 on Nondestructive Testing for many years.

(*Continued on page 80*)

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FOR FURTHER INFORMATION CIRCLE 721 ON READER SERVICE CARD PAGE 105

Personals

(*Continued from page 78*)

George S. Mikhalapov, former president of Coast Metals, Inc., Little Ferry, N. J., has been named executive vice-president of Brush Beryllium Co., Cleveland, Ohio.

Willis T. Moran, retired September 30 as chief of the Chemical Engineering Laboratory Branch of the U. S. Bureau of Reclamation's Engineering Laboratories at Denver, Colo., after continuous service since 1931. A recognized authority on cement chemistry, Mr. Moran made many important contributions to basic research on portland cement and in the investigations of pozzolanic materials as admixtures in concrete. He has been active in ASTM Committees C-1 on Cement, D-4 on Road and Paving Materials, and E-10 on Radioisotopes and Radiation Effects.

William G. Murphy has been named director of the engineering mechanics department at Marquette University College of Engineering, Milwaukee, Wis. He has been a member of Marquette's faculty since 1949.

I. A. Oehler has been elected executive vice-president and to the board of directors, The American Welding and Mfg. Co., Warren and Niles, Ohio. He was vice-president of operations.

Edward R. Oglio, formerly with the National Bureau of Standards, is now chemist, U. S. Bureau of Public Roads, Washington, D. C.

George L. Otterson, until recently with the U. S. Dept. of the Army, Office of Chief of Engineers, is now associated with Marquette Cement Mfg. Co., Chicago, Ill., as assistant technical director.

Earl R. Parker, professor of metallurgy and vice-chairman of the Division of Mineral Technology, University of California, Berkeley, delivered the Campbell Memorial Lecture of the American Society of Metals in Chicago in November. His subject was "Modern Concepts of Flow and Fracture."

Lucas E. Pfeiffenberger, ceramic engineer of Urbana, Ill., was named to the post of technical director of The Expanded Clay and Shale Assn. which has authorized an intensive test and research program for the development of additional information about the properties of expanded clay and shale lightweight aggregates. The laboratory of the Association is located at Alpena, Mich.

S. E. Platz has been appointed assistant chief metallurgist, The Duraloy Co., Scottdale, Pa.

Julian Pollak, formerly president, is now chairman of the board, Pollak Steel Co., Cincinnati, Ohio.

Stanley L. Proud is materials engineer, Wyatt C. Hedrick Co., Ocean Gate, N.J.

Elmer R. Queer, director and professor of engineering research, The Pennsylvania State University, University Park, Pa., was nominated for the presidency of the American Society of Heating and Air-Conditioning Engineers.

Neville M. Reiners has been named vice-president of research, Cummins Engine Co., Inc., Columbus, Ind. He has served with Cummins in various capacities for 20 years.

Frederick N. Rhines, professor of light metals at Carnegie Institute of Technology, Pittsburgh, Pa., was presented the 1957 Henry Marion Howe Medal during the American Society of Metals' annual National Metals Exposition and Congress in Chicago in November. Professor Rhines' citation was for a paper entitled "Grain Boundary Creep in Aluminum Bicrystals" published in the 1956 ASM *Transactions* under the authorship of F. N. Rhines, W. E. Bond, and M. A. Kissel.

(*Continued on page 82*)

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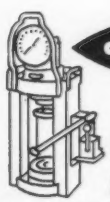
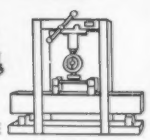
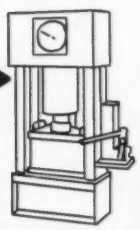

CT-711 CONCRETE TESTER


CT-375 BEAM TESTING MACHINE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FOR FURTHER INFORMATION CIRCLE 722 ON READER SERVICE CARD PAGE 105

HARSHAW SCIENTIFIC

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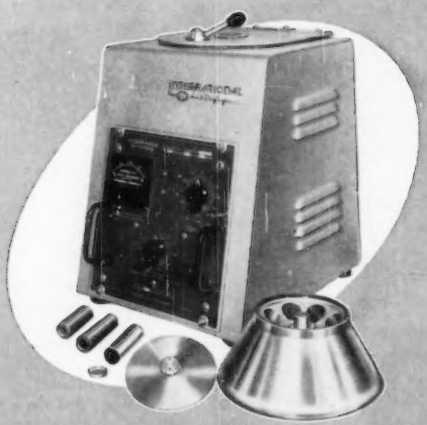
An International centrifuge is available for every need from stock. The complete line includes micro, clinical, chemical, routine, large capacity, explosion proof, blood plasma, refrigerated, oil testing, soil testing, and a number of other special application centrifuges. Complete information is available on the centrifuge you need. *Write for literature.*



H-9985—International Model HT, with steel guard bowl, complete instrumentation and 8-place angle head for 50 ml tubes (without tubes). For operation on 115 volts, 50/60 cycles, single phase $745.00

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H-8500—
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H-8858—Size 1, SBV
Routine and Research

H-9506—Size 2, V
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H-9875—Model PR-2
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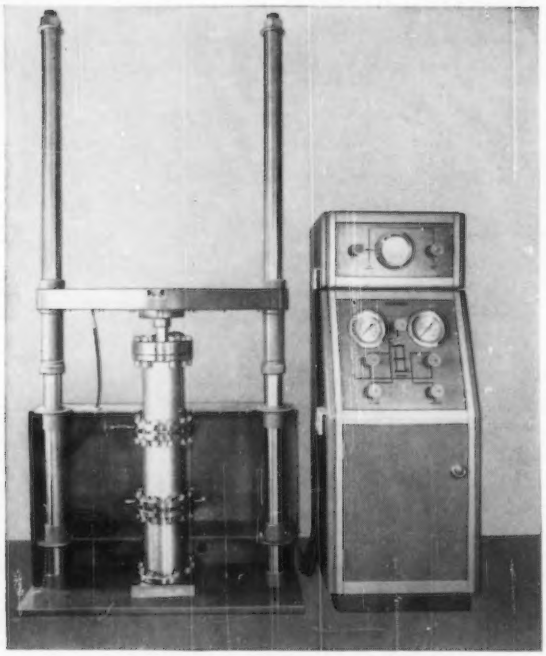

New shock tester—the HYGE-6000—available with 12″, 18″, and 37″ long cylinders.

NEW HYGE repeats shock patterns with 40,000 lbf. thrusts

Environmental shock testers now have a method of releasing as much as 40,000 lbf. of stored energy to produce predictable, reliable, and repeatable shock wave patterns.

The new six-inch Hyge produces square, sawtooth, and half-sine patterns to test and set standards for aircraft, missile, turbine, and rocket components as well as other parts subjected to high-*g* acceleration and deceleration.

The procedure . . . You specify the shock wave form you want the Hyge to produce—any of those mentioned above, alone, or in possible combinations.

CEC engineers then calculate your factors of mass, time base, and acceleration level of shock pulse. They design and produce a metering pin which controls the action of the Hyge shock tester precisely.

Hyge tests can simulate almost exactly actual service conditions. The tests are exactly repeatable with very short time lags for set-ups. Unit tests cost only pennies.

Hyge is versatile, small, and requires little maintenance or skill on the part of the operator. The operator does *not* enter the tests as a variable.

Since the whole Hyge principle is relatively new, you'll want more information on the HY-6000 and the smaller 10,000 lbf. Model HY-3000. Write for Bulletin 5-70-A.

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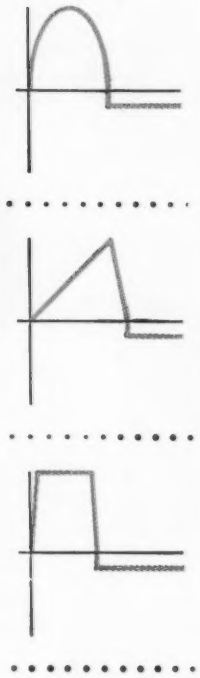
CIRCLE 724 ON READER SERVICE CARD PAGE 105

Typical shock patterns you can produce repeatedly with the Hyge shock tester



How Hyge works

Differential pressures acting on the upper and lower faces of a piston and seal in an orifice accumulate latent force in the Hyge. This force is released instantaneously when the higher pressure causes an overbalance of upward force to break the seal.

Thrust is transmitted directly through a column to the test platform which rides a braking rail. Pre-selection of metering pins controls the thrust pattern.

Personals

(*Continued from page 80*)

Raymond J. Rosenberger, formerly with The H. K. Ferguson Co., Specifications Div., Cleveland, Ohio, is now engineer of works, Gilbert Engineering Co., Gastonia, N. C.

George Sachs, professor of metallurgical engineering and associate director of the Syracuse University Research Inst., Syracuse, N. Y., has been honored by three German institutions for his many contributions to science and engineering. He was awarded the Gaussmedal by the Braunschweigische Wissenschaftliche Gesellschaft, an academy for engineers, physicists, and chemists of the Institutes of Technology in Braunschweig and Clausthal. He also received the Heyn Medal, the highest award of the Gesellshaft für Metallkunde. Both awards mentioned his outstanding achievements in the metallurgical field, including the mechanical and X-ray stress measurement methods developed by him. In addition, Dr. Sachs was awarded an honorary degree of doctor of engineering from the Bergakademie of Clausthal, the only university in West Germany devoted to mining and metallurgy.

Gordon W. Smith, formerly with Boston Gear Works, Quincy, Mass., is sales engineer, Frick & Lindsay Co., Pittsburgh, Pa.

James E. Stallmeyer has been promoted to associate professor at the University of Illinois, Civil Engineering Department, Urbana.

Alwin G. Steinmayer, vice-president of research and engineering, Line Material Industries, Div. of McGraw-Edison Co., Milwaukee, Wis., has been transferred to the grade of Fellow in the American Institute of Electrical Engineers ". . . for contributions to equipment for power distribution systems particularly in the field of cutouts and fuses."

Donald F. Stoneburner is at Carnegie Institute of Technology as the Union Carbide Corporation Fellow, working toward the degree of doctor of philosophy. He has been granted leave of absence from the Oak Ridge National Laboratory where he has been employed as an associate metallurgist.

George L. Sullivan has retired as dean, College of Engineering, University of Santa Clara (Calif.). He is succeeded by **Robert J. Parden.**

Angus J. Sutherland has accepted a position as emission spectrographer at Johns-Manville research center, Manville, N. J. He previously was with Limestone Products Corp. of America.

V. W. Swan, formerly with Reynolds Metals Co., Louisville, Ky., is now project engineer, Unit Products Co., Saline, Mich.

ASTM Past-President **J. R. Townsend** left Sandia Corp., Albuquerque, N. M., October 1, to accept a position as special

(*Continued on page 84*)

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Automatic Titrator

Using Second Derivative Method of H. V. Malmstadt

1. **Greater operational time saving than any former so-called automatic equipment.**
2. **No electrode problems. Most titrations can be carried out with plain platinum or platinum-rhodium wire electrodes.**
3. **Correct end point is automatically derived by the circuit — no statistical or theoretical studies needed. No pre-setting of voltages. Push-button start, automatic shutoff.**
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S-29690 ELECTROMETRIC TITRATION APPARATUS—Automatic, Potentiometer, Sargent-Malmstadt (Patents pending).

For use in all titrations usually classified as potentiometric. Consisting fundamentally of a mixing and delivery unit with associated supports and an electronic control circuit.

The control unit contains the detecting, amplifying, differentiating and relaying circuits with a simple operational panel. At the rear of the control unit are a stirring motor switch for manual use, a fuse, connecting outlets to the valve unit, connecting outlet to the power supply, and a recorder outlet permitting, for research purposes, the recording of the second derivative curve with automatic cutoff.

The delivery unit contains a valve mechanism with an adjustable rate controller, an open ended motor driven chuck for the stirrer, stirring motor and electrode holders. The valve mechanism, mounted on a support with swinging beaker platform and a clamp for the titrating burette, is designed to accommodate any form of burette with or without stopcocks, so that it may apply to any type of titrating installation.

Dimensions of control unit: height, 7¾ inches; width, 10 inches; depth, 9 inches; power consumption, 100 watts; total shipping weight, 35 lbs.

Complete, including: control unit; stirring valve unit; support stand with beaker platform and burette clamp; one S-30490 calomel electrode; one each S-30440 electrode, platinum and platinum rhodium; one S-29695 delivery tip with internal platinum electrode, one S-76667 stirring rod; one S-76668 large stirring rod; connecting cable for recorder; and connecting cord and plug for standard outlets. Without beakers or burettes. For operation from 115 vol, 60 cycle A.C. circuits..... **$450.00**

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FOR FURTHER INFORMATION CIRCLE 725 ON READER SERVICE CARD PAGE 105

Personals

(*Continued from page 82*)

assistant to the Assistant Secretary of Defense for Research and Engineering in Washington, D. C. He had been director of materials and standards engineering at Sandia since 1952; previously he had been for many years with the Bell Telephone Laboratories, Murray Hill, N. J. Mr. Townsend has served as consultant to the Assistant Secretary of Defense, R & D, since 1955, the Office of Defense Mobilization since 1956, and the Central Intelligence Agency since 1952. He is the recipient of citations from the Office of Defense Mobilization, Foreign Economic Administration, Army, Navy, American Standards Assn. and the Department of Defense for aid to government. In ASTM Mr. Townsend has been very active in administrative and technical phases of the Society's work, making valued contributions through the years. He was the 1930 ASTM Dudley Medalist. He served for 18 years as chairman of ASTM Committee B-6 on Die-Cast Metals and Alloys. He has been chairman of Committee E-1 on Methods of Testing for the past 10 years. He also serves on the ASTM Ordnance Advisory Committee and the Special Administrative Committee on Nuclear Problems.

Kent R. Van Horn, director of research, Aluminum Company of America, New Kensington, Pa., was the 1957 Mehl Honor Lecturer at the recent annual convention of the Society for Nondestructive Testing in Chicago. His lecture was titled "Mottling in Radiographs of Aluminum-Silicon-Copper Alloy Permanent Mold Castings." The Mehl Lecture is delivered biennially by an outstanding radiographer chosen by the NDT Board of Directors. Dr. Van Horn has been a member of ASTM Committee E-7 on Nondestructive Testing for many years.

Edmund M. Velten has been appointed technical director of The Beryllium Corp., Reading, Pa.

C. M. Wakeman, testing engineer, City of Los Angeles Harbor Dept., and past-chairman of the ASTM Southern California District Council, has been named chairman of the recently formed Committee (T9) on Marine Biological Deterioration of the National Association of Corrosion Engineers.

Richard S. Walker, formerly chief chemist, Virginia Rubber Corp., Clifton Forge, Va., is now nitrile rubber sales engineer, Rubber and Rubber Chemicals Dept., Chemical Div., Goodyear Tire and Rubber Co., Akron, Ohio.

Alfred C. Webber, research physicist, has been advanced to the rank of senior supervisor, Research Div., Polychemicals Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Mr. Webber has been very active for many years in ASTM technical work, particularly in activities of Committees D-9 on Electrical Insulating Materials, D-20 on Plastics, and E-1 on Methods of Testing. He currently is vice-chairman of Committees D-20 and E-1.

A. F. Wegener, formerly with Friez Instrument Div., Bendix Aviation Corp., Baltimore, Md., is now senior development engineer, Machlett Labs., Inc., Springdale, Conn.

S. R. Wiley, formerly with Johns-Manville Corp., is now associated with Davison Chemical Div., W. R. Grace Co., Baltimore, Md.

E. M. Williston has been promoted to manager of the newly organized Central Development Dept., Weyerhaeuser Timber Co., Longview, Wash.

Charles R. Wilson, until recently graduate assistant, Department of Civil Engineering, Fritz Lab., Lehigh University, Bethlehem, Pa., is now associated with Goodkind & O'Dea, consulting engineers, Teaneck, N. J.

Hans F. Winterkorn, professor of civil engineering at Princeton University, received the Officer's Cross of Merit of

(*Continued on page 86*)

engineering

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- Special ASTM apparatus like the unit illustrated and others made to ASTM specifications.
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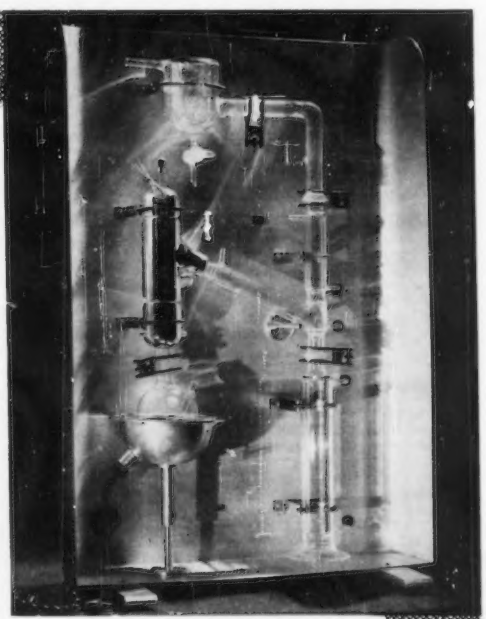

Unitized ASTM vacuum-distillation unit for running reduced-pressure distillations of petroleum products according to Method D-1160-52T.

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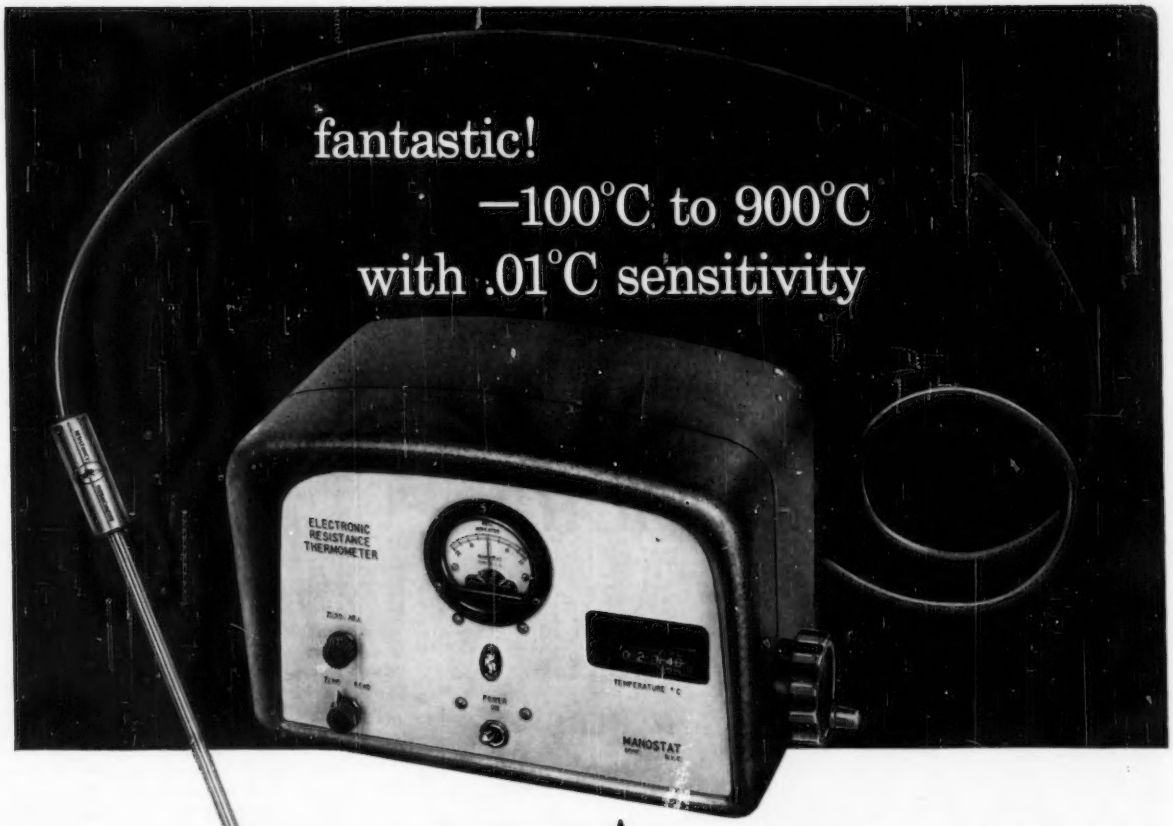

Absolutely incredible... but absolutely true! For the first time ever, here is the *only* thermometer which covers a range from —100°C to 900°C, with .01°C sensitivity and digital reading of temperature directly.

read temperature directly · no calculations necessary

- ▶ High Accuracy
  .10°C up to 400°C .20°C up to 900°C
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  - Hermetically sealed head
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- ▶ Plug-in controller accessory with .05°C reproducibility.

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By means of a special circuit in the Wheatstone bridge, the reading of the balancing variable resistor is made to follow a second degree relationship corresponding with the change in resistance of platinum with temperature. This gives a direct reading instrument which eliminates the time consuming calculations normally required with high precision resistance thermometry. A high sensitivity electronic detector permits rapid and precise balancing of the bridge.

PRICE LIST:

23525	Electronic Resistance Thermometer without bulb. Either 23525D or 23525E or both must be ordered at the same time as the thermometer and these will be individually calibrated	**1105.00**
23525D	Stainless Steel Bulb, only	**395.00**
23525E	Quartz bulb, only	**395.00**
23525E	Temperature controller, only	**112.50**

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FOR FURTHER INFORMATION CIRCLE 727 ON READER SERVICE CARD PAGE 105

Personals

(*Continued from page 84*)

the Order of Merit of the Federal Republic of Germany, presentation being made by Consul-General D. Adolph Rëifferscheidt at ceremonies in September at the University. Dr. Winterkorn was honored for major contributions to the engineering development of the United States and the Federal Republic of Germany. After the end of World War II, Professor Winterkorn conveyed unselfishly his knowledge and experience to scientists and engineers of the Federal Republic of Germany and contributed to a large extent to the reconstruction of his native country by assisting in the application of new methods in the building of roads and highways. In ASTM, Dr. Winterkorn has served for many years on Committees D-4 on Road and Paving Materials, and D-18 on Soils for Engineering Purposes.

A. L. Wooten has been appointed technical director of Reichhold Chemicals, Inc., New England division with headquarters at the Ballardvale, Mass., plant.

Dale J. Wright, formerly chief metallurgist of Caterpillar Tractor Co., Peoria, Ill., has been made manager of the company's reorganized quality control department. He has been with Caterpillar since 1934.

Clyde H. Wyman, until recently manager, product development, Vulcan Steel Foundry Co., Oakland, Calif., is now chief foundary metallurgist, The L.F.M. Mfg. Co., Inc., Atchison, Kans.

G. MacDonald Young, technical director, Aluminium Co. of Canada, Ltd., Fabricating Div., recently assumed presidency of the American Society for Metals. A 27-year man with Alcan, Mr. Young is especially familiar with the characteristics of aluminum and has done much work developing processes for fabricating new alloys and other materials for Canada's aircraft industry. He is the first Canadian to be elected president of ASM.

J. Stanley Young is now housing consultant, Faulkner, Kingsbury & Stenhouse, architects, Washington, D. C.

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CIRCLE 728 ON READER SERVICE CARD PAGE 105

Corrosion Engineers Form Marine Biological Group

NACE Technical Group Committee T-9 on Marine Biological Deterioration which held its organizational meeting at the Harbor Island, N. C., Test Station of the International Nickel Co., in June is an affiliate of the Marine Borer Group of the Sea Horse Inst., sponsored by the International Nickel Co., with the National Assn. of Corrosion Engineers. Chairman of the new committee is C. M. Wakeman who was co-chairman of the Symposium on Wood for Marine Use and Its Protection from Marine Organisms,[1] ASTM Second Pacific Area National Meeting, in Los Angeles, Calif.

Three unit committees were formed under Committee T-9: T-9A on Biological, C. E. Lane, chairman, University of Miami; T-9B on Preservations and Their Appraisal, T. R. Sweeny, U. S. Naval Research Labs.; and T-9C on Practical Applications, in the course of organization.

In consideration of the $50,000,000 yearly loss from marine-borer attack on wooden structures in United States waters, the work of Committee T-9 will include materials for preservation of wood in marine environments, compounds to kill or limit the activity of marine borers, collection of information on resistance of barrier materials to borer attack, adequacy of present specifications for marine piling treatment, and the establishment of standard preservative samples.

[1] *Special Technical Publication No. 200*, Am. Soc. Testing Mats. (1957).

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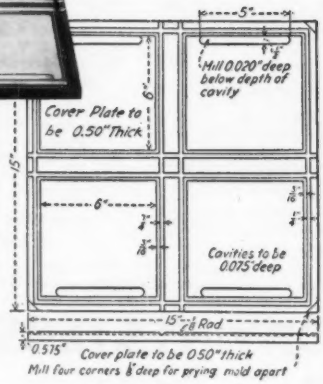

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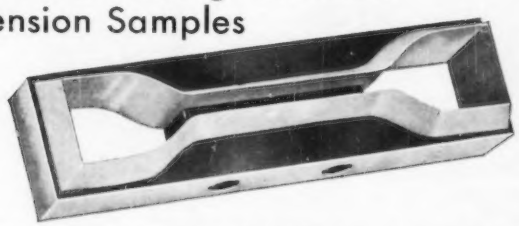

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NEW MEMBERS.....

The following 98 members were elected from September 18 to November 15, 1957, making the total membership 9147 ..... Welcome to ASTM.

Note—Names are arranged alphabetically—Company members first then individuals—Your ASTM Year Book shows the areas covered by the respective Districts

CHICAGO DISTRICT (5)

Rockwell Lime Co., Michael Brisch, president, R. 4, Manitowoc, Wis.

Baxter, Donald L., executive engineer, Reliable Electric Co., 11333 Addison St., Franklin Park, Ill.

Beaton, James L., materials engineer, Bendix Products Div., Bendix Aviation Corp., Bendix Dr., South Bend, Ind.

Dutton, Buell B., superintendent, Building Div., Village of Brookfield, 8820 Brookfield Ave., Brookfield, Ill.

Jerome, A. L., plant metallurgist, Caterpillar Tractor Co., East Peoria, Ill.

Liederbach, William H., ceramic process engineer, Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee, Wis. For mail: 202 Prospect Ave., Pewaukee, Wis.

McCullough, R. A., manager of engineering, Blaw-Knox Co., Construction Equipment Div., Mattoon, Ill.

Moburg, Keith W., research engineer, Ideal Industries, Inc., Park Ave., Sycamore, Ill. For mail: 158 Vista Terrace, Sycamore, Ill.

Myers, Gene A., metallurgist, McGill Manufacturing Co., Inc., 909 Lafayette St., Valparaiso, Ind.

Ryslinge, Anatole D., vice-president, Soils Engineering Laboratory, Inc., 3422 W. Hayes Ave., Milwaukee 15, Wis. For mail: 1137 S. 122nd St., Milwaukee 14, Wis.

Vellines, R. P., manager, Research Labs., Universal Atlas Cement Co., Gary, Ind. For mail: 3564 Jackson St., Gary, Ind.

Xavier, Miguel A., technical director, Inland Testing Labs., Division of Cook Electric Co., 6401 W. Oakton St., Morton Grove, Ill.

CLEVELAND DISTRICT (4)

Ford, W. E., technical service representative, Columbian Carbon Co., Box 209, Akron 9, Ohio.

Hartman, Robert H., chief chemist, Ferbert-Schorndorfer, Division of American Marietta Co., 12815 Elmwood Ave., Cleveland 11, Ohio.

McCue, William M. Jr., chief metallurgist, Steel Improvement and Forge Co., 970 E. 64th St., Cleveland 3, Ohio.

McEvoy, James E., manager, Development Lab., Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Vitek, Robert L., chemist, Man-Gill Chemical Co., 2338 Canal Rd., Cleveland 13, Ohio. For mail: 3687 Rolliston Rd., Shaker Heights 20, Ohio.

DETROIT DISTRICT (6)

Cataphote Corp., W. J. Larkin, new product and development manager, Toledo 10, Ohio.

Graham, Tom L., Jr., staff member in charge of testing, Wyandotte Chemicals Corp., Wyandotte, Mich.

Reinhard, John T., quality control engineer, Ann Arbor Construction Co., 221 Felch St., Ann Arbor, Mich.

NEW ENGLAND DISTRICT (13)

Tobe Deutschmann Co., Robert L. Stone, assistant manager, Engineering Div., Providence Highway, Norwood, Mass.

Klimas, Vincent A., technical supervisor, Inspector of Naval Material, 1026 Main St., Hartford, Conn.

Schulz, Herman R., senior experimental engineer, Royal McBee Corp., 1031 New Britain Ave., West Hartford 10, Conn.

NEW YORK DISTRICT (1)

Associated Commodity Corp., Ravi Datt, vice-president, 50th Fl., 233 Broadway, New York 7, N. Y.

Metalsalts Corp., Joseph A. Ramp, senior microbiologist, 200 Wagaraw Rd., Hawthorne, N. J.

Royal Lubricants Co., J. C. Mosteller, vice-president and technical director, River Rd., Hanover, N. J.

Wood, John Co., Stuart A. Faunce, director of research, Iorio Court, Union, N. J.

Benderson, Nathan, consulting engineer, 60 Washington St., Troy, N. Y.

Burchfield, William F., supervisor, mechanical engineering section, The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

Clark, Graham M., International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.

Gastler, A., Consolidated Edison Co. of New York, Inc., manager, Stock Control Bureau, Purchasing and Stores Dept., 4 Irving Pl., New York 3, N. Y.

Harris, Malcolm R., sales engineer, Baldwin-Lima-Hamilton, 111 Fifth Ave., New York, N. Y. For mail: 15 Harvard Rd., Cranford, N. J. [A]*

McFarlane, Robert P., plant chemist, Asiatic Petroleum Corp., Box 66, Bayonne, N. J.

Miller, Alex M., product development engineer, Rayco Manufacturing Co., 220 Straight St., Paterson, N. J.

*[A] denotes Associate member.

(*Continued on page 90*)

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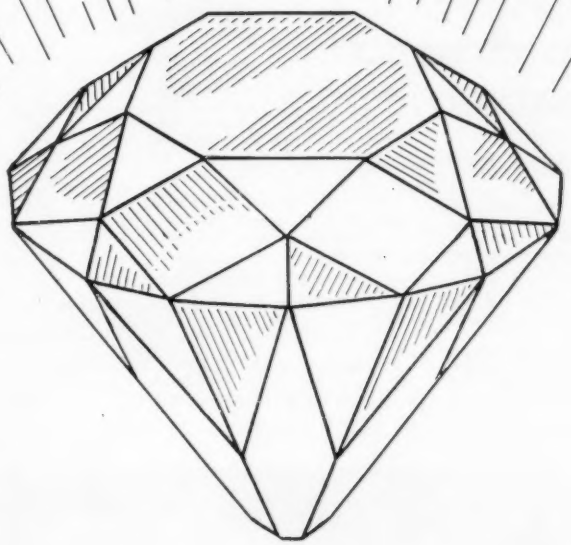

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New Members

(*Continued from page 88*)

Steiger, Leonard W., director of research, Maywood Chemical Works, 100 W. Hunter Ave., Maywood, N. J.

Waterbury, Adrian B., chief engineer, Walter Kidde Constructors, Inc., 140 Cedar St., New York 6, N. Y.

NORTHERN CALIFORNIA DISTRICT (8)

Lundgren, Raymond, chief soil and foundation engineer, Woodward, Clyde, Sherard and Associates, 1150 28th St., Oakland 8, Calif.

OHIO VALLEY DISTRICT (15)

Botkin, L. A., chief engineer, Buckeye Iron and Brass Works, Box 883, Dayton 1, Ohio.

Moor, Forest, president, Gro-Cord Rubber Co., 807 N. Jackson St., Lima, Ohio. For mail: 104 S. Dale Dr., Lima, Ohio.

Theodore, R. G., chief engineer, Electric Parts Corp., Box 234, Georgetown, Ky.

PHILADELPHIA DISTRICT (2)

Cannon, Oliver B., and Son, Inc., Wilfred H. Gibson, vice-president, 5604 Woodland Ave., Philadelphia 43, Pa.

Bender, R. O., assistant director, Petroleum Lab., E. I. du Pont de Nemours and Co., Inc., Box 1671, Wilmington 98, Del.

Bouman, Robert B., vice-president and general manager, Reese Metal Products Corp., 537 Howard Ave., Lancaster, Pa.

Davey, Merton H., partner, Andrew S. McCreath and Son, 236 Liberty St., Harrisburg, Pa.

Green, John G., chief engineer-plant production manager, The Interstate Amiesite Corp., Route 202, Concordville, Pa. For mail: Box 868, Wilmington 99, Del.

Johnessee, William H., metallurgist, Caterpillar Tractor Co., Memory Lane, York, Pa.

Johnson, C. L., head, analytical section, Eastern Lab., Explosives Dept., E. I. du Pont de Nemours and Co., Inc., Gibbstown, N. J.

Kessler, E. V., chief engineer, Philadelphia Bronze and Brass Corp., 22nd and Master Sts., Philadelphia 21, Pa.

Shepherd, B. Franklin, chief metallurgist, Ingersoll-Rand Co., Phillipsburg, N. J. For mail: Box 287, Phillipsburg, N. J.

Stein, Francis R., associate, John Diehl Associates, 40 Witherspoon St., Princeton, N. J.

Williams, Charles J., president, Charles J. Williams, Inc., 5300 Chew St., Philadelphia 38, Pa. For mail: 49 Rose Apple Rd., Levittown, Pa.

PITTSBURGH DISTRICT (3)

Spectrochemical Laboratories, Inc., W. S. Bates, vice-president, 1010 Wood St., Pittsburgh 35, Pa.

Hunt, Robert O., works engineer, Walworth Co., Huff Ave., South Greensburg, Pa.

Morrison, Neil T., director of research, Bell Clay Co., Gleason, Tenn. For mail: Box 757, East Liverpool, Ohio.

Winters, Harold M., electric engineer, Wheeling Steel Corp., Beech Bottom Works, Beach Bottom, W. Va.

ST. LOUIS DISTRICT (9)

Schubert, Robert F., development section supervisor, Monsanto Chemical Co., Monsanto, Ill.

SOUTHEAST DISTRICT (17)

Broome, Peter H., chief design engineer, Jack F. Cooper and Associates, Inc., 2320 N. E. 171st St., North Miami Beach, Fla.

Hendrickson, E. R., associate research professor, University of Florida, College of Engineering, Gainesville, Fla.

Michael, Richard E., quality control, Chemstrand Corp., Pensacola, Fla. For mail: Route 1, Box 274-A, Cantonment, Fla. [A]

Spoden, Harold T., consulting engineer, 214 Commerce St., Kingsport, Tenn.

Yoakum, Anna Margaret, head, chemical dept., Greenback Industries, Inc., Greenback, Tenn. [A]

SOUTHERN CALIFORNIA DISTRICT (7)

Chaffey College Library, Shirley L. Hopkinson, librarian, Fifth and Euclid, Ontario, Calif.

Eck, Richard C., sales engineer, Pacific Scientific Co., Box 22019, Los Angeles 22, Calif.

Nordstrom, D. M., Longview Fibre Co., 4955 Maywood Ave., Vernon, Calif.

SOUTHWEST DISTRICT (16)

Humble Oil and Refining Co., S. J. Lewis, division civil engineer, Box 626, New Orleans, La.

Ainsworth, J. L., chief chemist, Texas Butadiene and Chemical Corp., Box 777, Channelview, Tex.

Engle, J. P., laboratory group leader, Dowell, Inc., 1150 N. Utica, Tulsa, Okla.

Tennyson, T. A., engineer of tests and sanitation, St. Louis Southwestern Railway Co., Cotton Belt Shops, Pine Bluff, Ark.

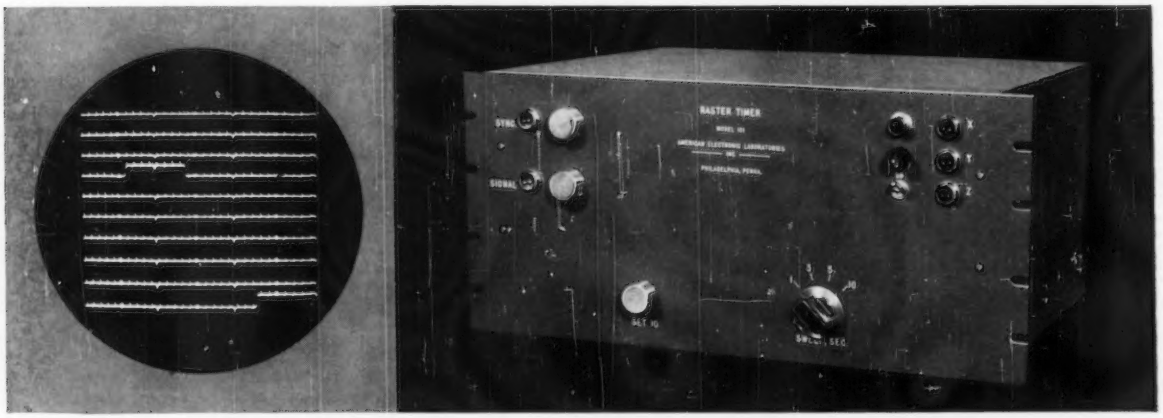
Vanbebber, W. C., branch manager, Baldwin-Lima-Hamilton Corp., 2356 Irving Blvd., Dallas 7, Tex.

WASHINGTON D. C. DISTRICT (14)

Demarest, William, director, plastics in construction, Manufacturing Chemists' Assn., 1625 Eye St., N. W., Washington 6, D. C.

Eaton, Herbert N., consulting engineer, 13809 Colesville Rd., Silver Spring, Md.

(*Continued on page 92*)



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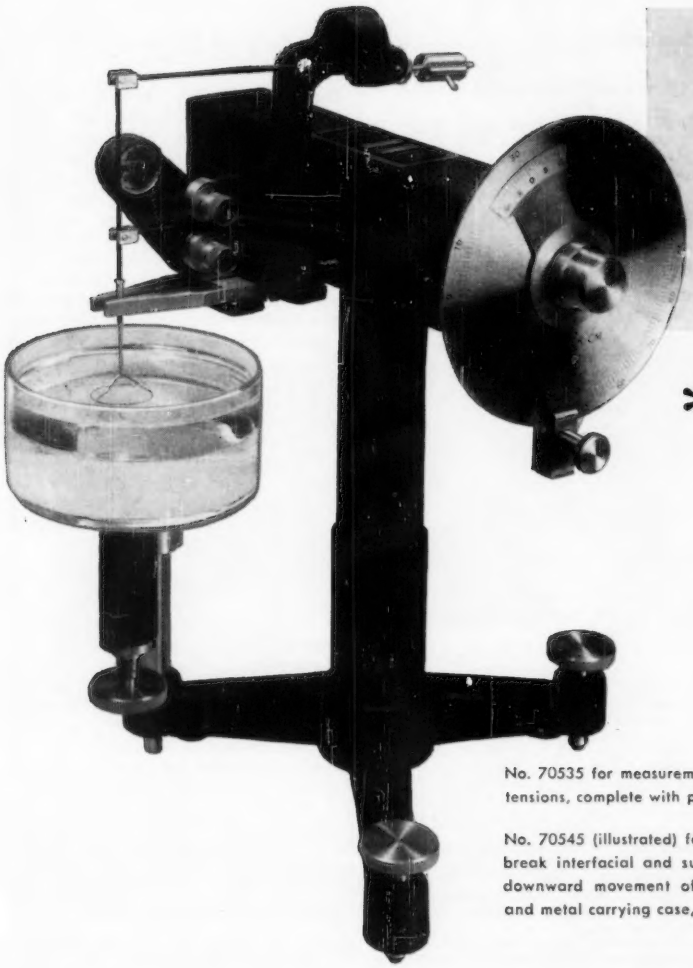

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CIRCLE 736 ON READER SERVICE CARD
PAGE 105

New Members

(Continued from page 90)

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Cooper Corps., Peter, John R. Hubbard, vice-president, Palmer St., Gowanda, N. Y.

Desmond, Joseph P., librarian, Cornell Aeronautical Laboratory, Inc., 4455 Genesee St., Buffalo 21, N. Y.

Fahlstrom, George B., director, Research Div., Osmose Wood Preserving Co., 980 Ellicott St., Buffalo 9, N. Y.

Steele, Stephen G., assistant professor, Broome Technical Community College, Binghamton, N. Y. [A]

U. S. AND POSSESSIONS

Sundstrand-Denver, Division of Sundstrand Machine Tool Co., Engineering Library, Edward J. Rupert, chief metallurgist, 2480 W. 70th Ave., Denver 21, Colo.

Lieboner, William S., process engineer, F. C. Torkelson Co., 39 E. First St., S., Salt Lake City 1, Utah.

OTHER THAN U. S. POSSESSIONS

Cotton Textile Consolidation Fund, Cherif Hassan, general manager, 26A, Sherif Pacha St., Immobilia Bldg., Cairo, Egypt.

Farbenfabriken Bayer AG, Ing. Wiss. Abt., Horst Miebner, Leverkusen, Germany.

"Inspectorate" International Inspection Office, I. Momtaz Moussa, managing director, 19, Grupellostrasse, Düsseldorf, Germany.

Mene Grande Oil Co., J. L. Hammer, superintendent, Production Dept., Apartado 234, Maracaibo, Venezuela.

Niederrheinische Hütte A.G., Kurt Brandenburg, technical director, Postfach 566, Duisburg, Germany.

Pembroke Shook Mills, Ltd., Cecil E. Miller, laboratory engineer, 330 Forced Rd., Pembroke, Ont., Canada.

Cox, Guillermo Larco, civil engineer, Jose Galvez, 999, La Victoria, Lima, Perú. For mail: Javier Prado 1915, San Isidro, Lima, Peru. [A]

Duby, John, president, Duby Engineering Associates, Ltd., 10032–105 St., Edmonton, Alta., Canada. [A]

Gerty, Arthur Edward, deputy manager, Technical Div., Regent Oil Co., Ltd., 117 Park St., London, W. 1, England.

Kwon, Chang Hyok, manager, Research Dept., Korean Reconstruction Bank, Seoul, Korea.

Lloyd, J. B., general manager, Northern Petroleum Corp., Ltd., Kamsack, Sask., Canada.

Mathis, Sam J., chief general engineer, Creole Petroleum Corp., Apartado 889, Caracas, Venezuela.

Mayo, F., refinery manager, Esso Petroleum Co., Ltd., The Esso Refinery, Fawley, Hants, England.

Monk, W. B., senior technical service representative, Du Pont Company of Canada (1956), Ltd., Textiles Fibres Div., Box 210, Kingston, Ont., Canada.

Notini, Ulf Gunnar, director of research, Jernkontoret, Kungsträdgårdsgatan 6, Stockholm, Sweden.

Polak, Mario Witold, president and general manager, The Damar Systems, Ltd., 227–8 Alberta Corner, Calgary, Alta., Canada.

Raman, K. S., India Cements, Ltd., Madras, India. For mail: 3 Sankarnager, Thalaiyuthu, Tironel Velli, Madras, India. [A]

Rutherford, N. B., head of research, Thomas Bolton and Sons, Ltd., Froghall, Stoke-on-Trent, Staffs., England.

Tepel, Rudolf, inspecting engineer, Inspectorate, International Inspection Office, 19, Grupellostrasse, Duesseldorf, Germany. For mail: 63, Duesselforferstrasse, Osterath, Düsseldorf, Germany. [A]

DEATHS . . .

Frank N. Alquist, Organic Research Lab., Dow Chemical Co., Midland, Mich. (September 25, 1957). Representative of his company since 1944 on Committee D-19 on Industrial Water, and a valued contributor to the work of this main committee and a number of the subcommittees. He had served as chairman of Subcommittee VI on Corrosivity and Performance Testing for a number of years, and represented Committee D-19 on the Advisory Committee on Corrosion. He represented ASTM on the Research Council on Causes and Methods of Prevention of Internal Corrosion of Water Pipes since 1951. Dr. Alquist was held in very high esteem by all ASTM members who knew him. One of his major contributions to ASTM activities was in connection with symposia which he developed for meetings. At the time of his death he was heading up a symposium for the Society's 1958 meeting.

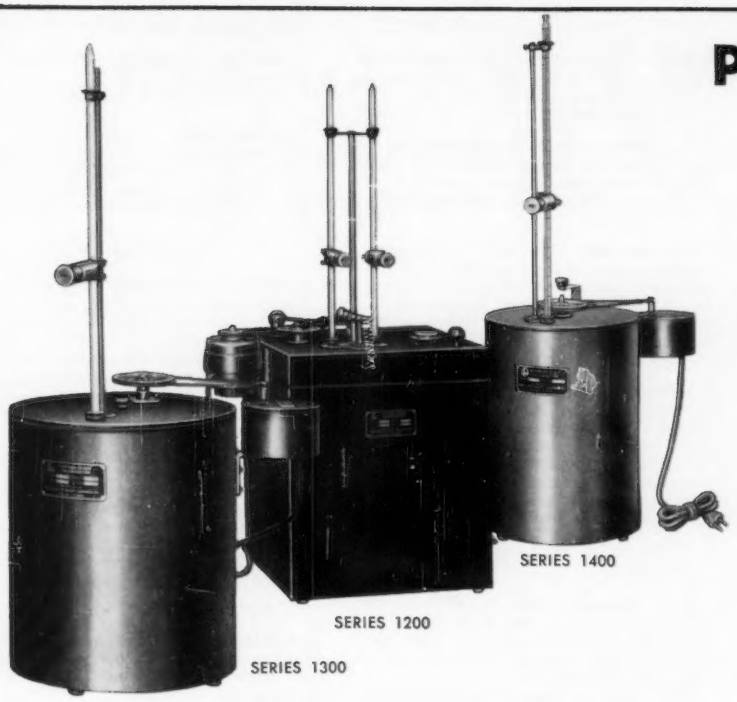
W. E. Byron Baker, director of research, New York and Pennsylvania Co., Inc., Lock Haven, Pa. (October 30, 1957). Member of Society since 1949, and member of Committee D-1 on Paint, Varnish, Lacquer, and Related Products, and its Subcommittee XVI on Printing Inks since 1950. He had been with the firm since 1931. Mr. Baker had been active also in certain committees of the Technical Committee of the American Pulp and Paper Assn.

B. S. Court, chief metallurgist, Hayes Steel Products Ltd., Merritton, Canada (April 29, 1957). Representative of company membership since 1956.

Randle E. Dunning, Textile Testing Dept., Merritt Clothing Co., Mayfield, Ky. (July 22, 1957). Member since 1948.

Lesley McCreath, Andrew S. McCreath and Son, Chemists, Harrisburg, Pa. (August 17, 1957). Member since 1908.

Paul Dyer Merica, who retired as president of The International Nickel Co. of Canada, Ltd., in April, 1954, but continued to serve the company on important projects and as consultant to the officers, died on October 20. He was 68. He was a director of The International Nickel Co. of Canada, Ltd., and its United States subsidiary, The International Nickel Co., Inc. and of American Metal Co., Ltd., Babcock & Wilcox Co. and Whitehead Metal Products Co., Inc. He had been associated with International Nickel since 1919. For his contributions in the field of metallurgy and outstanding leadership in physical metallurgy, Dr. Merica had received many honors and awards. Active in many technical and professional groups, he had been elevated to honory membership in the American Society for Metals in 1955. He had been a member of ASTM since 1915, and had made valued contributions to the work of the Society, especially in his earlier years, particularly in Committees A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, and B-2 on Non-Ferrous Metals.



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FOR FURTHER INFORMATION CIRCLE 737 ON READER SERVICE CARD PAGE 105

NEWS NOTES ON
Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The Society is not responsible for statements advanced in this publication.

LABORATORY ITEMS

Cathode-Ray Recorder—The new 204-A12 dynamic temperature and strain recorder features 12 channels of simultaneous data in addition to a calibrated linear time base and zero time on a 10-in. wide by 31½-in. long record.
Allegany Instrument Co., Inc. 1462

Control Cabinet—A new standard inductor alternator control cabinet is available. The wall-mounted cabinet is used with standard inductor type alternators ranging from ⅔ to 30 kva, 3 phase, and from ¾ to 15 kva, 1 phase.
American Electronics, Inc. 1463

Tester Measures Transistors—An accurate system which determines the basic parameters of a transistor has been designed into this new unit. Beta and Ico are examined as well as the Figure of Merit of a transistor.
Armour Electronics, Inc. 1464

Infrared Double-Beam—A simplified low cost infrared instrument, the Double-Beam automatic recording IR-5 Spectrophotometer has been introduced.
Beckman Scientific Instruments Div. 1465

Leak Detector—A new Beckman infrared-type leak detector utilizing an infrared principle to detect nitrous oxide gas is available.
Beckman Instruments, Inc., Process Instruments Div. 1466

Thickness-Density Gauge—A thickness-density gauge utilizing cobalt 60 or other gamma emitting radioactive sources has been developed.
Budd Co., Nuclear Systems Div. 1467

Balance—Model M-10 Electrobalance, precision balance has maximum capacity to 100 mg without loss of sensitivity or accuracy on lower ranges.
Cahn Instrument Co. 1468

Concrete Freeze and Thaw Test—A cam program potentiometer recorder controller (Model CB-20-705) monitors freezing and thawing cycles to meet ASTM requirements for rapid freezing and thawing in water (C 290 – 52) or rapid freezing in air or thawing in water (C 291 – 52) and slow freezing and thawing in water or brine (C 292 – 52). The equipment will process 60 specimens at one time and up to 8 complete cycles in a 24-hour period with unattended operation.
Conrad, Inc. 1469

Corrosometer—Detects electrically, the loss of metal in increments of 0.5 microinch of metal loss.
The Crest Instrument Co. 1470

Traction-Type Dynamometers—Development of two new traction-type dynamometers has been announced. The two new instruments have capacity ratings of 0–5000 lb and 0–10,000 lb and complete line throughout the 0 to 1,000,000 lb capacity range.
W. C. Dillon & Co., Inc. 1471

(*Please turn page*)

Lab Items

(*Continued from page 93*)

Compression Tester—The new Model LT-600 is a 350,000 lb capacity precision machine, specifically for testing concrete and concrete products in compression and flexure, according to ASTM Specifications and established laboratory procedure.
Forney's, Inc. 1472

Transistor Null Detector—Model 2050 used in conjunction with other battery operated equipment, allows complete isolation from the power lines. This feature, plus battery operation, provides a lower noise level which makes it useful in all types of a-c bridge measurements.
Freed Transformer Co., Inc. 1473

Megohmmeter—New 500 volt d-c test potential portable megohmmeter, Model 2030 is a battery operated instrument with a transistor power supply.
Freed Transformer Co., Inc. 1474

Recording Reflectometer—The instrument is capable of measuring whiteness, degree of yellowness, bleaching and fading, amount of blueing, tinting strength, and a number of other factors involved in controlling the color of materials on a production line or moving web.
Gardner Laboratory, Inc. 1475

Siphon-Pump—A new hand-operated, self-starting siphon-pump designed for the safe handling of concentrated acids.
General Scientific Equipment Co. 1476

Optical Protractor—A new instrument for rapid, accurate, and dependable angular measurements for a high range of applications, permitting direct readings without using reference tables or blocks.
Wm. J. Hacker & Co., Inc. 1477

Temperature Bath—A high temperature testing bath for testing hydraulic thermostats for operations up to temperatures of 600 F using salt as liquid heating medium.
Labline, Inc. 1478

Gas Analyzer—The new "Chromomax" Analyzer can analyze as many as four process streams containing natural gases, vapors, low boiling point liquids and hydrocarbons, with eight such components in each stream.
Leeds & Northrup Co. 1479

Moisture Content—The new Model I Volatimeter, is an instrument for determining the moisture content of solids with greater speed. The new instrument uses a syringe method for determining water content in solids. It measures the volume of water vapor volatilized from the particles of the specimen just below the melting point.
Manufacturers Engineering and Equipment Corp. 1480

Film Measurement—The Model II Scattermaster is a new instrument for transmission measurements of films and sheets which are important in determining surface imperfections.
Manufacturers Engineering and Equipment Corp. 1481

Carbon 14—A comprehensive stock of commonly used carbon 14 labeled compounds has been added to the line of radioactive isotopes.
Nucleonic Corp. of America 1482

Decade Scaler—An improved basic decade scaler for precision counting and registering of electrical impulses is known as the "Candid" Decade, Model DS-1A—a utility instrument with wide application in laboratories.
Nuclear Measurements Corp. 1483

Electron Microscope—A new Norelco Electron Microscope (EM-75-B) for analytical work in industrial processing, research, medicine, pathology and biology. Objective lens has an externally adjustable mechanical compensator with a single control, indexed and coupled to double dipoles positioned on the face of the pole shoe.
Philips Electronics, Inc. 1484

X-Ray Microscopy—A new Norelco Projection Microradiograph, designed for X-ray microscope techniques and other applications in metallurgical, rubber, plastics, mineralogical, agricultural, pharmaceutical, and biological fields.
Philips Electronics, Inc. 1485

Conductivity Cell—A newly developed conductivity cell for mounting directly on the main process line of free-flowing liquids.
Robertshaw-Fulton Controls Co. 1486

High Temperature Pyrometer—A new high temperature measuring instrument, now being introduced accurately measures the temperature of hot objects without touching them. The instrument, called the Land Radiation Pyrometer, measures the radiant energy given off by hot objects.
Robertshaw-Fulton Controls Co. 1487

DC Amplifier—One of a new series of Sanborn units, is designed to drive an optical galvanometer, oscilloscope, or tape recorder. Input characteristics of the new amplifier include an impedance of 200 K differentially between terminals (balanced), or 100 K each input lead to ground (single-ended).
Sanborn Co., Industrial Div. 1488

Ball Penetration Apparatus—A new instrument for determining the consistency of fresh concrete is made in accordance with ASTM Specification C 360, Ball Penetration in Fresh Portland Cement Concrete.
Soiltest, Inc. 1489

Bend-Tester—New Model GB-124 Guided Bend Tester, a self-contained unit, designed specifically for guided bend testing with improved accuracy, and faster testing.
Steel City Testing Machines, Inc. 1490

Creep Tester—A 6000 lb creep–rupture testing machine of the lever type. Based on General Electric Co. design, the Tatnall creep–rupture testing machine has a lever ratio of 10 to 1.
Tatnall Measuring Systems Co. 1491

Laboratory Press—The new model 1210-N hydraulic laboratory press exerts a full 12-ton pressure, despite the fact it is a very compact unit. The 7 by 10 in. platens are blanchard ground and are electrically heated.
Wabash Metal Products Co. 1492

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MICRO-HARDNESS TESTERS

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fine wire • very thin metal • shallow superficially-hardened surfaces • small components • surface coatings • jewels plastics • glass • and many other materials

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FOR FURTHER INFORMATION CIRCLE 378 ON READER SERVICE CARD PAGE 105

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monium phosph... um tartrate, S
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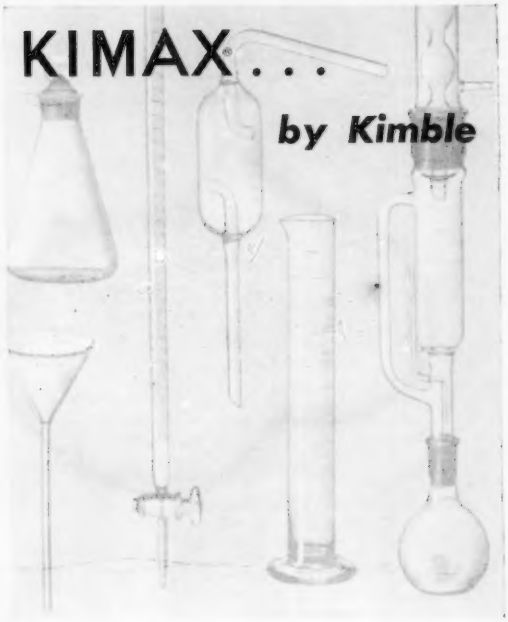

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CATALOGS AND LITERATURE

Glassware—Catalog entitled "Laboratory in Miniature" details available miniature glass apparatus.
Ace Glass, Inc. 2310

Ultracentrifugation—In a new publication identified as *Form SBE-2*, it provides a summary of the various rotors and their cells and accessories which are available for the widely varied purposes of analytical ultracentrifugation.
Beckman Instruments Inc., Spinco Div. 2311

Analog-to-Digital Converter—A four-page brochure on the Beckman all transistor analog-to-digital converter. This high speed adc was originally developed for use in the Beckman Model 112 data handling system.
Beckman Instruments, Inc., Systems Div. 2312

Temperature Control—Illustrated four-page, two-color brochure *No. 5510-A*, on a variety of Blue M temperature control equipment features Power-O-Matic industrial batch ovens which have fully automatic proportional wattage control and temperature range to 600 F with a capacity from 16 to 96 cu ft.
Blue M Electric Co. 2313

Ovens—Illustrated 48-page, two-color miniature catalog, *No. M-57*, covers a complete line of electric ovens and furnaces.
Blue M Electric Co. 2314

Polisher—Book describes metal polishes for samples, Vol. III, *No. 4* Metal Digest.
Buehler, Ltd. 2315

Radiographic Materials—A complete line of industrial radiographic materials are illustrated and described in a new pamphlet, "Materials and Accessories for Industrial Radiography" which contains a guide chart for selection of film for various material thicknesses.
Eastman Kodak Co., X-Ray Sales Div. 2316

Bunsen Burner—Newsletter describes the electrothermal "Bunsen." This is a new source of heat for numerous applications in the laboratory. It has an element temperature range of 800 to 1000 C.
Gardner Laboratory, Inc. 2317

Laboratory Catalog—Laboratory Spotlight, *No. 14*, describes labware.
The Harshaw Chemical Co. 2318

Optical Products—A new 2-page illustrated bulletin, *HW 8-57*, describes a variety of precision quality control instruments for optical products, and lists detailed catalogs available for each instrument.
Jarrell-Ash Co. 2319

Glassware—A newly revised manual on "The Care and Handling of Glass Volumetric Apparatus" is available to laboratory workers, technicians, and students. The 24-page booklet offers valuable information and assistance in prolonging life and accuracy of glass measuring instruments.
Kimble Glass Co. 2320

Carbon Analyzer—A bulletin showing typical laboratory results and describing the apparatus in full detail for carbon determination may be obtained upon request.
Laboratory Equipment Corp. 2321

Sulfur Analysis—A complete line of Leco accessory items for use with all types of carbon and sulfur analysis apparatus is contained in a new brochure.
Laboratory Equipment Corp. 2322

Electronic Relay—Revised data sheet describes electronic relay designed especially for safe operation of laboratory water baths. Revision lists components for constructing water baths.
Arthur S. LaPine & Co. 2323

Phase-Angle Voltmeter—Sixteen pages of "Application Notes" on the Model VM-200 series phase angle voltmeters provide set-up diagrams and procedures for the many research, test, and production applications of the multifunctional instrument.
North Atlantic Industries, Inc. 2324

Radiochemistry—Four-page bulletin, *No. 408*, describes the applications of radiochemical techniques that may be used to obtain technical data.
Nuclear Science and Engineering Corp. 2325

Autrometer—A new 8-page booklet, giving complete information on the improved autrometer, automatic indexing X-ray Spectrograph, is available gratis.
Philips Electronics, Inc. 2326

Projection Microradiography—A new folder on projection microradiography containing photos and micrographs which illustrate the new instrument and its application is available.
Philips Electronics, Inc. 2327

Oscillographic Recording—A new 16-page catalog contains descriptions, specifications, and prices of all Sanborn 150 oscillographic recording systems and the full line of 150 accessories and unit instruments.
Sanborn Co. 2328

Polyethylene Ware Catalog—A fully illustrated, 16-page catalog, *No. 57P*, describes polyethylene laboratory glassware.
Schaar & Co. 2329

Color-Code—A handy chart containing color codes and calibration symbols for thermocouple extension wires plus pyrometer wire resistance figures.
Thermo Electric Co., Inc. 2330

Kentrall Hardness Testers—A new bulletin describes the four Kentral combination hardness testers. Each of these hardness testers makes both regular and superficial Rockwell tests and costs about the same as "single-function" testers.
The Torsion Balance Co. 2331

Catalog—A new catalog, *No. 7*, of laboratory apparatus is thumb-indexed, speed-exed and sub-indexed—with many reference tables, comparison charts, and other buying aids throughout.
Will Corp. 2332

INSTRUMENT COMPANY NEWS

Atmosphere Control Co., Inc., Phila., Pa.—The new ACC-Prototype Design and Mfg. Division will handle individual and production runs of spinnings up to 92 in. in diameter, up to ½ in. thickness, in aluminum, brass, bronze, rolled steel, and stainless steel.

Beckman Instruments, Inc., Fullerton, Calif.—The board of directors announced the acquisition of the outstanding stock of Arnold O. Beckman, Inc., of South Pasadena, Calif., which manufactures oxygen analyzers for hospitals, scientific laboratories, and industrial process control. It was established as a sole proprietorship in 1942 by Arnold O. Beckman and was incorporated in 1946.

Beckman Instruments, Inc., Palo Alto, Calif.—Reorganization of the Shockley Semiconductor Laboratory of Beckman has been announced. Maurice C. Hanafin, formerly manager of the Beckman Spinco Div. has been named manager of the Shockley Semiconductor Lab. located at Palo Alto and Mountain View, Calif.

BeAl-rt Products, West New York, N. J.—Bel-Art has acquired Dubonnet Products. This will round out its services with the new Dubonnet Acetate Div. and the formation of a new Vacuum Forming Dept.

The Budd Co., Phila., Pa.—Has purchased the Krouse Testing Machine Co. of Columbus, Ohio, manufacturers of a broad line of fatigue testing machines, announced by the president, Edward G. Budd, Jr.

Burrell Corp., Pittsburgh, Pa.—R. M. Arnold has been elected to the presidency of Burrell Corp. Guy H. Burrell, retiring president, continues active as chairman of the board. Mr. Arnold has been with the Pittsburgh scientific firm for 21 years, becoming a vice president in 1952.

Hallikainen Instruments, Berkeley, Calif.—Announces the recent addition to its staff of E. F. Schimbor as vice-president and sales manager, and W. C. Bagot as purchasing agent.

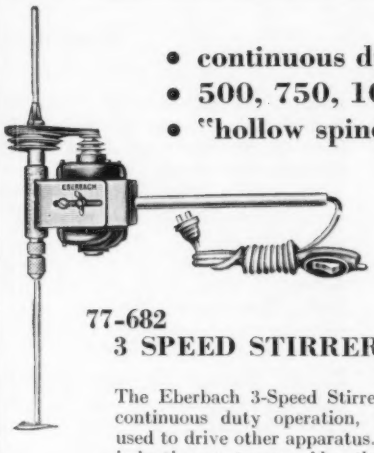
Instron Engineering Corp., Quincy, Mass.—In order to meet stepped-up demands for its electronic testing equipment, Instron Engineering Corp. is building a new 25,000 sq ft plant in Canton, Mass. Located at the intersection of Routes 128 and 138, Instron's new plant will be devoted to the design and production of universal testing machines and other electronic test equipment. The building will also house the company's administrative and engineering offices.

Narda Corp., Mineola, L. I., N. Y.—John C. McGregor, president of The Narda Corp., a leading name in microwave and UHF test equipment, has announced the company's entry into the new, fast-growing ultrasonics industry. A subsidiary, the Narda Ultrasonics Corp. has been formed as a separate operating group.

Radiation Counter Labs., Inc., Skokie, Ill.—Has started an expansion program which will double the size of its present plant. Completion of the 6400 sq ft addition will increase RCL's present production capacity 100 per cent. The addition will give them needed production and administration space.

Technique Associates, Inc., Indianapolis, Ind.—Manufacturers of temperature measuring and indicating instruments, has moved its general offices and plant to larger quarters at 1413 N. Cornell Ave., Indianapolis 2, Ind.

(*Continued on page 98*)



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- 500, 750, 1000 RPM
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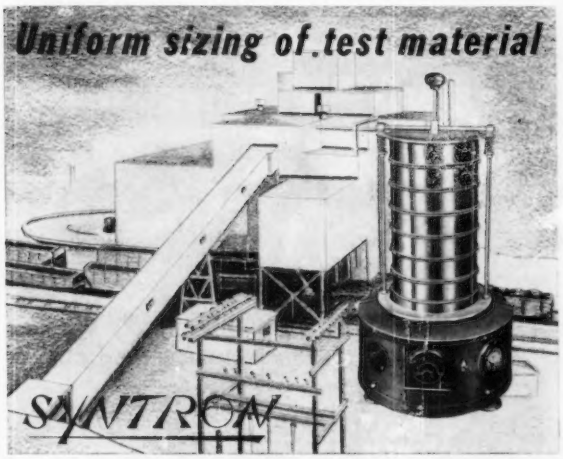

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(*Continued from page 96*)

TESTlab, Chicago, Ill.—TESTlab, a new corporation engaged in the manufacture and marketing of apparatus and equipment for the laboratory and field engineering testing of soils, bituminous, and concrete materials, has gone into production.

NEWS OF LABORATORIES

Greer Engineering Associates, Inc., Montclair, N. J.—David M. Greer has formed a partnership with G. Kenneth Jewell for the consulting practice of Soils and Foundation Engineering in Columbus, Ohio, under the name Greer-Jewell & Associates. In addition to consulting work, the firm will maintain a soil testing laboratory for service to other engineers of the Columbus area. Offices and laboratory will be at 195 Chittenden St., Columbus 1, Ohio.

Reynolds Metals Co., Richmond, Va.—A six-million-dollar research and office building will be erected here by Reynolds Metals Co., and the aluminum firm's general sales offices will be moved to Richmond from Louisville, Ky. Richard S. Reynolds, Jr., president, stated that the new research building will be constructed on a site adjacent to the $10 million building, now nearing completion, which will house the company's executive offices. The research building will house packaging and metallurgical laboratories which already are in Richmond as well as other company research facilities.

Foster D. Snell, Inc., New York, N. Y.—With the purchase of another ten story building, Foster D. Snell, Inc., organization of consulting chemists and chemical engineers, virtually doubles its present capacity for conducting research and development work for the chemical and allied industries in New York. The building is located at 28 West 15th Street.

Truesdail Labs., Inc., Los Angeles, Calif.—Truesdail Labs., Inc., takes pleasure in announcing an association with Abbott A. Hanks, Inc., Engineers, Assayers, Chemists, and Metallurgists in San Francisco in providing sampling and testing facilities for air pollution investigations in the Bay Area.

SPE Proposes Plastics Institute

THE SOCIETY of Plastics Engineers has appointed Jerome Formo chairman of a special committee to develop plans for the formation of a Plastics Institute. It will provide facilities for both fundamental and developmental research, education for those in any branch of the industry and an unparalleled library for reference and study. All segments of the plastics industry will benefit from the Institute and will be invited to participate in its program and facilities.

Further information can be had from Jerome Formo, 2753 Fourth Ave. South, Minneapolis, Minn.

D. P. Barnard Deputy Assistant Secretary of Defense was Formerly Active in ASTM Committee

D. P. BARNARD of Chicago, research coordinator for the Standard Oil Co. (Indiana), who became Deputy Assistant Secretary of Defense (Research and Engineering) on July 1, was for many years a member of ASTM Committee D-2 on Petroleum Products and Lubricants. He was a member of the committee in the period 1934 to 1937 while he was assistant director and later associate director of research at the Whiting, Ind., Refinery of the Standard Oil Co.

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(*Continued from page 65*)

the more corrosion-susceptible spots the maintenance engineer should clean the surface a little better and apply the best available coating and the designer should avoid undesirable shapes wherever possible.

With so many laboratories and test programs in operation, it is inevitable that some duplication of work will occur. It is refreshing and reassuring that in those cases where the work of Fancutt and Hudson was simulated by someone else, the conclusions of ASTM Committee D-1, Subcommittee 29, and the statement on pages 30 and 31 concerning the value of phosphoric acid washes applied to various types of steel surfaces prior to painting essentially agree.

The section on the standard of deterioration at which repainting should be done agrees surprisingly well with similar work reported in the ASTM *Proceedings*, Vol. 49 (1949).

The reviewer warmly recommends this 102-page book to the investigator of metal painting problems, to the formulator who must start somewhere when formulating a paint for exterior steel structures, and to the maintenance engineer whose problem it is to clean the surface and apply the coating.

A. J. EICKHOFF

Engineering Structural Failures

Rolt Hammond, Philosophical Library, New York, N. Y., 224 pp., $12.

WITH the increasing advances in engineering skill and knowledge, and in the magnitude of this work, the need for accurate and frank recording of structural failures is of growing importance. Rarely, in papers read before professional societies, do we find a frank analysis of errors of design and execution. Literature on the subject is scattered through many papers and journals and in numerous reports which are not always accessible. The author of this book provides a survey of both the causes and the results of failures in a number of countries in a variety of examples, including earthworks, dams, buildings, harbors, bridges, and tunnels.

Of special interest to ASTM members might be the final chapter, which reviews modern methods of testing materials, ranging from X-ray and electronic developments to the de Havilland aircraft pressure-test tank.

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WITH this new periodical the Austrian Society for Research on Wood has created a representative publication. The editor-in-chief is Prof. Dr. Josef Kisser (University for Soil Culture, Vienna). Steady contributors of the editorial staff are very well known specialists. The purpose of the periodical is to be a connecting link between research and practice. It brings original studies from the Austrian Research on Wood Institute; contributions from prominent experts from here and abroad; short communications about new results in the field of chemical and mechanical technology of wood; a wood documentation with a title bibliography of important publications in the professional field here and abroad, compiled by the documentation office of the Austrian Society for Research on Wood; and newspaper articles and continuous information about new standards in the field of wood.

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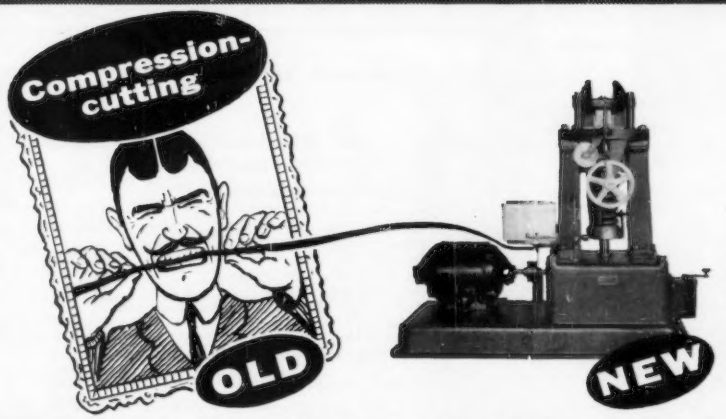

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Federal Government Standards Index Changes

THE General Services Administration of the Federal Supply Service is charged with the responsibility for establishing specifications to be used by the Federal Government for procurement of materials and supplies. The GSA issues an annual Index of Initiation of Federal Specifications Projects, as of March 1, and monthly supplements.

The items listed below appeared in Supplements Nos. 6 and 7 for the months of August and September 1957.

INITIATIONS:

Title	Type of Action	Symbol or Number	FSC Code	FSSC Class	Assigned Agency & Preparing Activity
Cleaning Compound, Synthetic Detergent (Non-Abrasive)	New	Federal Standard			GSA-FSS
Cloth, Cotton, Corduroy	Rev.	CCC-C-591a	8305	83	DOD-Army-QMC
Cloth, Cotton, Duck, Bleached	New	CCC-C-442	8305	83	DOD-Army-QMC
Compound; Cleaning Soap-Abrasive Type (For Painted Surfaces)	Rev.	P-C-565	7930	51	GSA-FSS
Film, Photographic, Black and White; General Specification For	Am. 1	L-F-330	6750	18	DOD-USAF
Leather, Cattlehide (Insole)	Am. 1	KK-L-159	8330	83	COM-NBS
Leather, Cattlehide, Veg-Tanned, and Soles, Leather	Am. 1	KK-L-165	8330	83	COM-NBS
Lumber and Timber, Softwood	Rev.	MM-L-00751e	5510	..	GSA-FSS
Molding Plastic, (Poly-(vinyl Chloride), Rigid; Rods and Tubes	New	L-M-540	9330	..	DOD
Perchloroethylene (Tetrachloroethylene, Technical Grade	Rev.	O-P-191a	6810	..	DOD-Navy-Ships
Rope, Yarn and Twine, Hemp	Am. 1	T-R-675	4020	40	DOD-Navy-Ships
Soap and Soap-Products (Including Synthetic Detergents); Sampling and Testing	Chg. Notice 1 Federal Standard No. 536				COM-NBS
Soap, Grit (Hand, Paste and Powder)	Am. 1	P-S-577	8520	51	GSA-FSS
Soap, Toilet, Liquid and Paste	Rev.	Int. Fed. Standard No. 0013a			GSA-FSS
Soap, Laundry (Chip)	Rev.	P-S-580 & P-S-00580 (GSA-FSS)	7930	51	GSA-FSS
Tolerances for Copper and Copper Alloy Mill Products	New	Federal Standard			DOD-Army-Ord.

TITLE AND SYMBOL CHANGES:

Title	Type of Action	Symbol or Number	Former Title or Symbol
Cloth, Cotton, Bunting, Mercerized	New	CCC-C-439a & CCC-C-00439 (GSA-FSS)	Bunting; Cotton, Mercerized, CCC-B-791a
Cloth, Cotton, Cheesecloth, Bleached and Unbleached	New	CCC-C-1440	Cheesecloth, Bleached and Unbleached CCC-C-271a
Sodium Borate Decahydrate, Technical (Borax)	Rev.	SS-S-00535	SS-B-611, Borax (Sodium Borate)

PROMULGATIONS:

Title	Type of Action	Symbol or Number
Aluminum Alloy 1100 (2S); Plate and Sheet (Superseding Fed. Spec. QQ-A-56lb)	Rev.	QQ-A-561c
Aluminum Alloy Sand Castings (Superseding FS QQ-A-601a)	Rev.	QQ-A-601b
Anodes, Cadmium (Superseding FS QQ-C-61)	New	QQ-A-671
Bags; Textile, Shipping, Burlap, and Waterproof Laminated (Superseding IFS PPP-B-0035 (COM-BDSA)	New	PPP-B-35
Brass; Castings, Leaded Yellow (Superseding Fed. Spec. QQ-B-621a)	Rev.	QQ-B-621b
Cable, Power, Electrical (Armored Including Lead-Covered Types and Armored Cord) (Superseding IFS J-C-007lb (GSA-FSS) and FS J-C-71a)	Rev.	J-C-71c
Calking Cotton	New	T-C-30
Copper-Beryllium Alloy Strip	Am. 2	QQ-C-533
Copper-Nickel-Zinc-Alloy Plate, Sheet, Strip, and Rolled Bar	Am. 1	QQ-C-585
Ethyl Acetate, Technical, Organic Coatings Use (Superseding Fed. Spec. TT-E-751)	Rev.	TT-E-751a
Hose, Rubber, Water (Yarn-Reinforced) (Superseding FS ZZ-H-601)	Rev.	ZZ-H-601a
Hose, Water, Wrapped	Am. 1	ZZ-H-611a
Magnesium Alloy, Sand Castings (Superseding FS QQ-M-56)	Rev.	QQ-M-56a
Molding Plastic, Cellulose Acetate (Superseding FS L-P-344)	New	L-M-505
Pigments-in-Oil, Tinting Color	Am. 2	TT-P-381c
Pipe Fittings, Cast Iron, Screwed 125 and 250 Pound	Am. 1	WW-P-501c
Pipe, Steel (Seamless and Welded (For Ordinary Use)) (Superseding Fed. Spec. WW-P-406)	Rev.	WW-P-406a
Rods, Welding, Aluminum and Aluminum Alloys	Am. 2	QQ-R-566
Sacks, Shipping, Paper, Reinforced (Superseding IFS PPP-S-0050 (GSA-FSS)	New	PPP-S-50a
Soap, Grit (Hand, Paste and Powder)	Am. 1	P-S-577
Soap, Toilet, Powdered, for Use in Dispensers (Superseding Int. Fed. Spec. P-S-00626d (GSA-FSS) and Fed. Spec. P-S-626c	Rev.	P-S-626e
Sodium Chloride, Technical, for Water Softening Units (Superseding Int. Fed. Spec. SS-S-0026a (GSA-FSS) and Fed. Spec. SS-S-26)	New	SS-S-550
Steel Bars and Forgings, Graphitic	Am. 3	QQ-S-628
Steel Bar, Reinforcing (For) Concrete (Superseding Fed. Spec. QQ-B-71a)	New	QQ-S-632
Wax, Carnauba (Superseding IFS JJJ-W-00141a (GSA-FSS and FS JJJ-W-141)	Rev.	JJJ-W-141b
Zinc; Sheet and Strip (Superseding Fed. Spec. QQ-Z-301a)	Rev.	QQ-Z-301b

INTERIM FEDERAL SPECIFICATIONS ISSUED:

Title	Type of Action	Symbol or Number
Concrete, Ready-Mixed	New	SS-C-00618
Detergent (Synthetic) Built, High and Low Sudsing	Am. 1	P-D-00245
Film, Radiographic, Industrial and Medical	New	W-F-00350
Lumber and Timber, Softwood	Rev.	MM-L-00751e
Molding Plastic, Poly(Vinyl Chloride), Rigid	New	L-M-00530
Molybdate Orange, Dry, Paint Pigment	New	TT-M-00570
Soap, Laundry, Chip	New	P-S-00580
Soap, Toilet, Liquid and Paste	New	Int-Fed. Std. 0013a
Thread, Cotton	New	V-T-00276c
Webbing and Braid, Textile, Elastic	New	JJ-W-00155
Zinc-Dust (Metallic-Zinc-Powder): Dry (Paint Pigment)	New	TT-Z-00291a
Zinc-Yellow (Zinc Chromate): Dry (Paint Pigment)	New	TT-Z-00415a

CANCELLATION:

Title	Symbol or Number	Reason for Cancellation
Aluminum and Aluminum Alloy Wrought Products Tolerances For	QQ-A-245	Superseded by Fed. Std. No. 245
Bars; Reinforcement, (For) Concrete	QQ-B-71a	Superseded by Fed. Spec. QQ-S-632

SPECIFICATIONS AND STANDARDS APPROVED FOR PRINTING:

Title	Type of Action	Symbols or Numbers
Boxes, Wood, Nailed and Lock-Corner	Am. 1	PPP-B-621
Brass, Leaded and Non-Leaded; Plate, Rolled Bar, Sheet and Strip	Rev.	QQ-B-613a
Bronze, Manganese and Aluminum-Manganese, Castings	Rev.	QQ-B-726d
Cadmium; Anodes	Canc.	QQ-C-61
Cleaning Compound, Soap Abrasive, Paste, For Painted Surfaces	New	P-C-442
Cable, Power, Electrical (Armored Including Lead-Covered Types and Armored Cord)	Rev.	J-C-71c
Copper-Nickel-Zinc-Alloy Plate, Sheet, Strip, and Rolled Bar	Am. 1	Q-C-585
Glassware; Methods for Sampling and Testing	New	Fed. Std. No. 626
Glassware, Laboratory; Methods for Sampling and Testing	Canc.	DD-G-626a
Hose, Rubber, Water (Yarn-Reinforced)	Rev.	ZZ-H-601a
Hose, Water, Wrapped	Am. 1	ZZ-H-611a
Hydrometers, Graduated Scale (For General Laboratory Use)	New	GG-H-925
Molding Plastic, Cellulose Acetate	New	L-M-505
Molding Plastic, Polystyrene	New	L-M-520
Molding Plastic, Polystyrene, Modified	New	L-M-525
Pigments-in-Oil, Tinting Color	Am. 2	TT-P-381c
Plastics; Cellulose Acetate, Molded	Canc.	L-P-344
Soap, Grit (Hand, Paste and Powder)	Am. 1	P-S-577
Soap, Laundry, Bar	Rev.	P-S-591e
Tube, Magnesium-Alloy, Extruded	Rev.	WW-T-825a
Union, Pipe, Steel or Malleable Iron, Threaded Pipe Connection, 250 psi WSP; 500 p.s.i. WOG (Cold, Nonshock)	Rev.	WW-U-531a
Wax, Carnauba	Rev.	JJJ-W-141b

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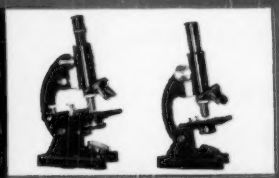

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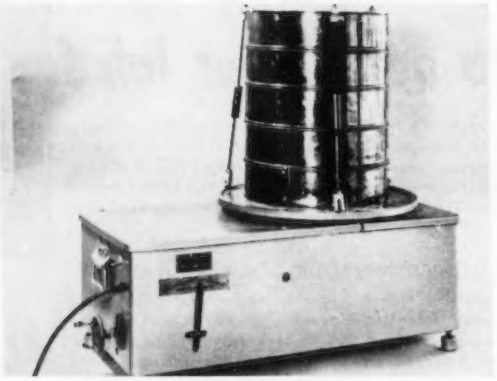

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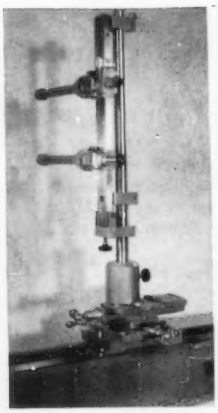

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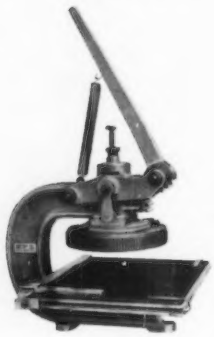

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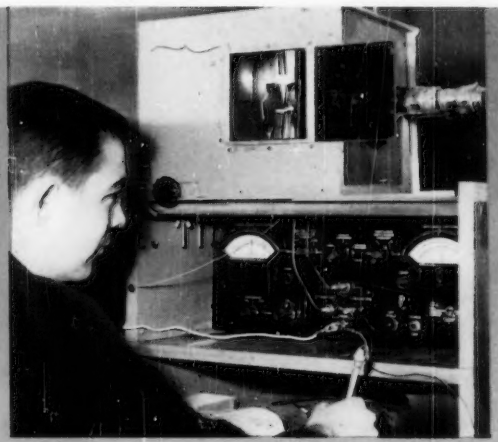

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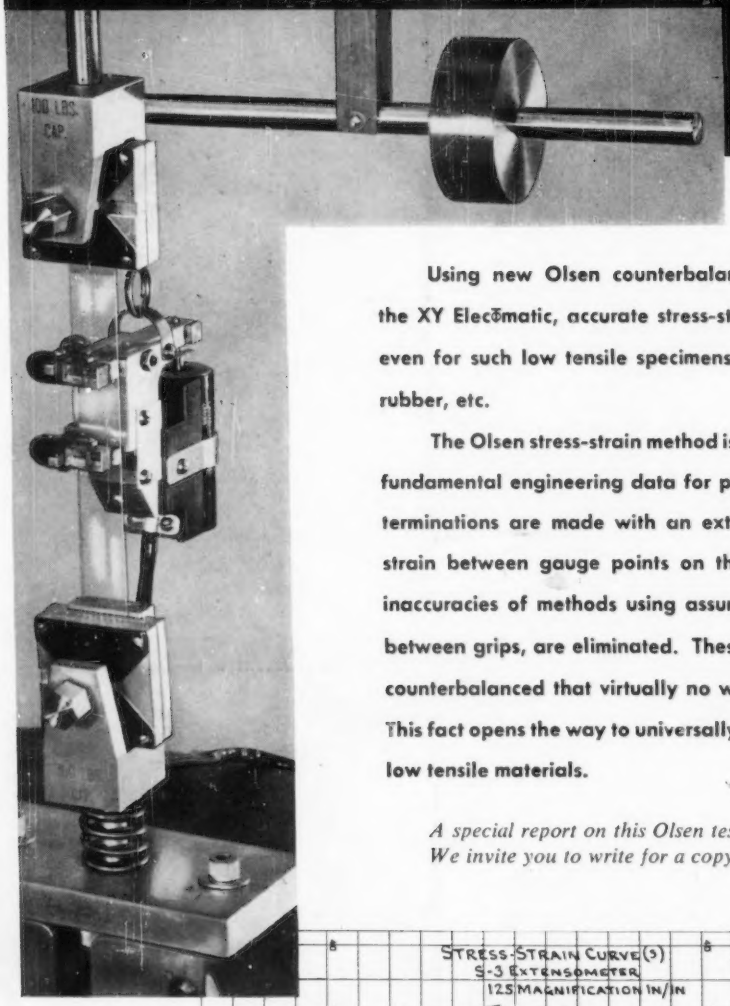

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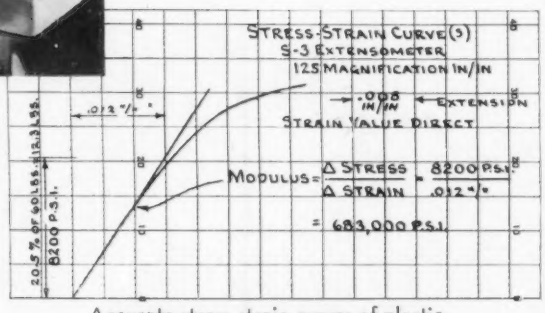
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